Ossipee Lake and Tributaries
Water Quality Monitoring Program QAPP

Green Mountain Conservation Group (GMCG)
Blair Folts, Executive Director
P.O. Box 95, South Effingham, New Hampshire 03882
(603) 539-1859
&
Ossipee Lake Alliance (OLA)
David Smith, Executive Director
P.O. Box 173, Freedom, NH 03836
(203) 655-6728

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13 August 2003

Ossipee Lake Alliance

GREEN MOUNTAIN CONSERVATION GROUP

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

N·H·C·F

1. APPROVAL PAGE

GMCG Program Director
Blair Folts, Green Mountain Conservation Group

Signature Date

OLA Program Director
David Smith, Ossipee Lake Alliance

Signature Date

Project QA/QC Officer
Rebecca Hanson, Ossipee Lake Protection Program

Signature Date

NHDES Program QA Coordinator
Andrea Donlon, NHDES

Signature Date

NHDES QA Manager
Vincent Perelli, NHDES

Signature Date

USEPA QA Manager
Alan Peterson, USEPA

Signature Date

USEPA Project Manager
Warren Howard, USEPA

Signature Date

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3. DISTRIBUTION LIST

The following table lists the people who will receive a copy of the QAPP and subsequent revisions:

Table 1: Document Distribution

QAPP Recipients	Organization/Address	Telephone/Email
David Smith	Ossipee Lake Alliance P.O. Box 173; Freedom, NH 03836	(203) 655-6728 dsmith@ossipeelake.org
Blair Folts	Green Mountain Conservation Group P.O. Box 95; South Effingham, NH 03882	(603) 539-1859 bfolts@earthlink.net
Rebecca Hanson	Ossipee Lake Protection Program c/o Green Mountain Conservation Group P.O. Box 95; South Effingham, NH 03882	(603) 539-1859 gmcg@worldpath.net
Andrea Donlon	Watershed Assistance Section NH DES P.O. Box 95; Concord, NH 03302	(603) 271-8862 adonlon@des.state.nh.us
Vincent Perelli	Office of the Commissioner NH DES P.O. Box 95; Concord, NH 03302	(603) 271-8989 vperelli@des.state.nh.us
Jody Connor	Volunteer Lake Assessment Program, Limnology Center NH DES; P.O. Box 95 Concord, NH 03302	(603) 271-3414 jconnor@des.state.nh.us
Jeffrey Schloss	Water Resources Research Center University of New Hampshire 131 Main Street, 224 Nesmith Hall; Durham, NH 03824	(603) 862-3848 jeff.schloss@unh.edu
William McDowell	Water Resources Research Center University of New Hampshire, James Hall; Durham, NH 03824	(603) 862-2249 bill.mcdowell@unh.edu
Warren Howard	US EPA, Region 1, 1 Congress St., Boston, MA 02114-2023	(617) 918-1587 Howard.Warren@epamail.epa.gov

This document will be available for reference at the program's office in Freedom Village, NH for participants and other interested parties. Program participants will also receive a separately produced handbook containing all of the information needed for field and administrative work.

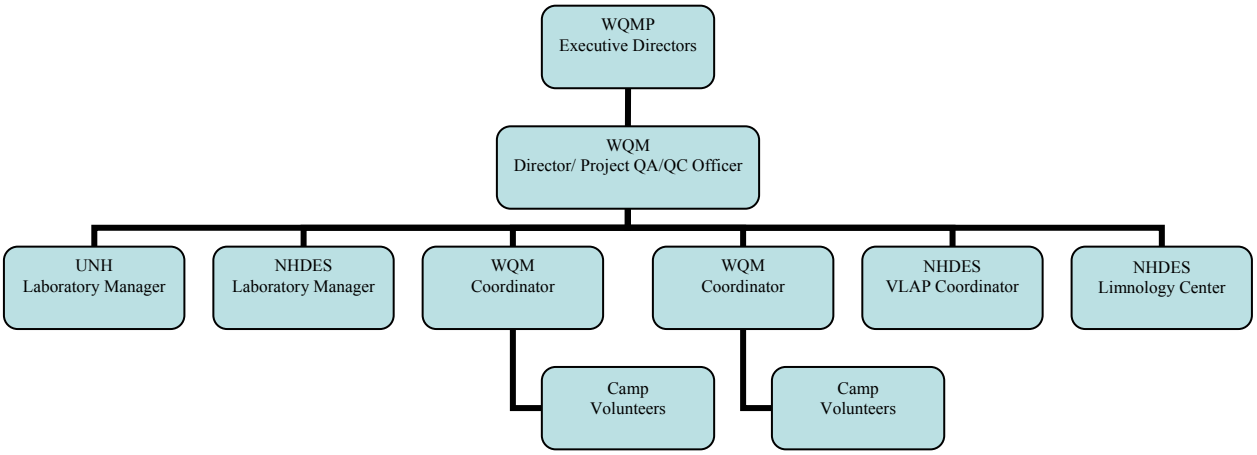
4. PROJECT & TASK ORGANIZATION

The Ossipee Lake & Tributaries Water Quality Monitoring Program (WQMP) is a joint initiative of Ossipee Lake Alliance (OLA) and Green Mountain Conservation Group (GMCG) with primary underwriting provided through a Watershed Assistance Grant from the New Hampshire Department of Environmental Services (NHDES) and Clean Water Act Section 319 funds from the United States Environmental Protection Agency (USEPA). The OLA and GMCG organizations are described in Section 5.

The WQMP will be managed by a water quality monitoring Program Director-QA/QC Officer (WQM Director) who will report to the Executive Directors of Ossipee Lake Alliance and Green Mountain Conservation Group (Executive Directors). Two Field Coordinators (WQM Coordinators) will report to the WQM Director and will be responsible for liaison with the children's camps participating in the program (Camp Volunteers) and for ensuring that water samples are delivered to laboratory contact personnel at the New Hampshire Department of Environmental Services (NHDES) and the University of New Hampshire (UNH).

Figure 1 illustrates how the project has been organized and will be managed:

Figure 1: Organization Chart



As shown in Figure 1, the WQM Director will be responsible to the WQMP Executive Directors for the day-to-day management of the WQMP. The WQM Director will train the two WQM Coordinators in tributary testing and will arrange for the NHDES Volunteer Lake Assessment Program (VLAP) Coordinator to train the Coordinators for deep spot testing. The WQM Director is responsible for the overall supervision of the Coordinators in obtaining water samples and either processing them or delivering them to the appropriate laboratory. The Coordinators in turn are responsible for supervising the Camp Volunteers who participate in the WQMP.

The program proposes to sample water on Ossipee Lake and its tributaries with lake samples analyzed by NHDES and tributary samples analyzed by UNH. A final report on the program will be written by the NHDES and UNH Laboratory Managers and the WQM Director under the supervision of the Executive Directors. Table 2 details the responsibilities of the key personnel.

Table 2: Responsibilities

POSITION	RESPONSIBILITIES
OLA & GMCG Executive Directors (Executive Directors)	The OLA and GMCG Executive Directors will have overall responsibility for the WQMP. They will manage the WQM Director and ensure that the project is continuously working towards its goals. They will develop and update the QAPP and related program documentation and will maintain funding.
WQM Program Director & Project QA/QC Officer (WQM Director)	The WQM Director will implement and monitor quality control procedures; monitor instrument maintenance, calibration, and reliability; audit documentation from sample analysis, ensure instrument maintenance and calibration, manage data processing and store the Field Data Sheets; assist the Executive Directors with the development of the QAPP; and ensure that all documentation is complete and accurate. The WQM Director will train the WQM Coordinators on all aspects of tributary sampling and will be responsible for ongoing performance evaluations of the WQM Coordinators. The WQM Director will be the primary contact person for the NHDES and UNH Laboratory Managers and the NHDES VLAP Coordinator.
Field Coordinators (WQM Coordinators)	The WQM Coordinators will oversee all water sampling. They will coordinate field sampling schedules with camp contacts; order necessary equipment and supplies; implement the field sampling onsite; maintain project results in database and hard copy form; perform weekly back-ups of database files; and perform scheduled quality control checks and training. They will ensure that water samples are properly preserved for processing by NHDES and UNH.
NHDES VLAP Coordinator	The NHDES VLAP Coordinator will be responsible for training the WQM Coordinators in the use of all equipment required for NHDES VLAP deep-water tests. The VLAP Coordinator will also be responsible for providing deep water testing equipment.
Camp Volunteers	The Camp Volunteers are campers and counselors at the six participating children's camps on the Ossipee Lake system. They will provide boat transportation to testing sites as required. For tributary testing, Camp Volunteers will observe the sampling processes and procedures and learn about the importance of water testing. For deep-water sampling they will perform water collection tasks as defined in this manual under the supervision of the WQM Coordinators.

POSITION	RESPONSIBILITIES
NHDES and UNH Laboratory Managers	The NHDES and UNH Laboratory Managers will perform all testing not done on site; submit the test results to the Program Managers; and work closely with WQM Director to ensure quality control.

Table 3 lists the names and telephone contact numbers for the primary participants in the day-to-day implementation of the WQMP:

Table 3: WQMP Personnel Contact Information

David Smith, Executive Director, OLA	**203-655-6728**
Blair Folts, Executive Director, GMCG	**603-539-1859**
Rebecca Hanson, WQM Director	**603-539-1859**
Moselle Spiller, WQM Coordinator	**603-539-1859**
Sarah Van Cor Hosmer, WQM Coordinator	**603-539-1859**
Andrea LaMoreaux, NHDES VLAP Coordinator	**603-271-2658**
Chuck Illig, Camp Robin Hood	**603-539-4500**
Jody Skelton, YMCA Camp Huckins	**603-539-4710**
Don Johnson, Camp Calumet	**603-539-4773**
Rachael DeAngelis, Camp Cody	**603-539-4997**
Steve Harding, Camp Tohkomeupog	**603-367-8460**
Dayna Rousseau, Camp Marist	**603-539-4552**
Bob Craycraft, UNH Laboratory	**603 862-3696**
Andy Chapman, NHDES Limnology Center	**603-271-3414**
Rachel Rainey, NHDES Laboratory	**603 271-2993**

5. PROBLEM DEFINITION & BACKGROUND

Green Mountain Conservation Group
Formed in 1997, Green Mountain Conservation Group (GMCG) is a non-profit charitable organization dedicated to natural resource conservation in the Ossipee Watershed. Through education, research, advocacy and land conservation, it promotes awareness and appreciation of the watershed's natural resources and encourages a commitment to protect those resources. Its guiding principle is to present objective information in a non-confrontational manner to enable the public to make informed natural resource decisions.

Ossipee Lake Alliance
Ossipee Lake Alliance (OLA) was formed in 2002 as an umbrella organization to create a lake-wide community of interest to preserve and protect Ossipee Lake and its adjacent land. It links concerned individuals, property owner associations, children's camps and environmental groups in research, planning, education and advocacy to address environmental, quality of recreation and land use issues. OLA focuses on programs that have measurable impact, create wide public awareness, and promote community volunteerism.

Ossipee Lake & the Ossipee Watershed
Ossipee Lake is at the heart of the Ossipee Watershed, the drainage area of which is bound by the mountains of the Sandwich Range to the northwest, the Ossipee Mountains to the south and the sandy pine-barrens of the Ossipee-Freedom-Effingham plains to the east. The watershed contains New Hampshire's largest stratified-drift aquifer. This type of aquifer recharges more rapidly than any other aquifer, but also allows pollution and contamination to be carried more rapidly into the underground water supply. As a result, conservation of the recharge lands is vital to the protection of drinking water supplies.

Ossipee Lake is the state's seventh largest lake and includes five connecting bodies of water: Ossipee Lake (the main lake), Broad Bay, Leavitt Bay, Berry Bay, Danforth Pond and Huckins Pond. These waters, fed by 14 tributaries, comprise more than 4,000 acres of water.

A significant economic contributor to the towns of Freedom, Ossipee, and Effingham, the lake is a primary destination for vacationers, boaters and wildlife enthusiasts and its very attractiveness has put it under developmental pressure and environmental stress. Particularly vulnerable are its unique ecological assets. In addition to the aquifer, the lake's unique features include two extremely rare sandy pond shore communities, one of the state's finest examples of pine-barrens, and a federally protected kettlehole quaking bog.

In 1995, the Environmental Protection Agency listed Ossipee Lake area as one of top five areas in New Hampshire to protect. To date, however, there has been no comprehensive lake stewardship plan or public education campaign on the unique value of the lake's features.

In January, 2003, OLA and GMCG were awarded a watershed assistance grant from the New Hampshire Department of Environmental Services (NHDES) for a series of initiatives under the title Ossipee Lake Protection Program (OLPP). These initiatives will establish baseline data on

water quality and the quality of recreation on the lake and will support education outreach to residents and visitors about the lake's unique ecological assets and the need to protect them.

OLPP's water quality monitoring program (WQMP) entails sampling the lake's 14 tributaries twice monthly during the summer months and conducting deep water sampling monthly at the deep spots of the lake's five main bodies of water. OLA has enlisted the lake's six children's summer camps to assist in the program, marking the first time the camps have worked together on a lake environmental initiative.

Intended Use of the Data

Data from the WQMP will be used for the most part within this program to understand the lake system as a whole and to educate the region about the watershed. As the program continues into the future, changes in water quality over time will be observed. The data will show the overall condition of the water so that future plans for the region may be made based on sound scientific information.

Systematic water quality monitoring has never been conducted on Ossipee Lake, although there has been ad hoc testing in the past. While the focus for the WQMP is as part of the Ossipee Lake Protection Program, it is anticipated that the results will have broader applicability and use. For example, this year's water sampling will be combined with data from the RIVERS program, which is in its second year of testing tributaries in the Ossipee Watershed under the direction of GMCG and the Saco River Corridor Commission (SRCC) to improve the overall baseline of water information and enhance knowledge in the entire region. The testing parameters for the WQMP were selected so that these two programs would have comparable data with only a few variations, thereby improving their overall usefulness.

Baseline data are important to science in multiple ways. The collection of these data helps expand the knowledge of how lakes behave and change over time. The possibilities of how these data may be used in the future are too many to list here. Suffice it to say that this location is already a state treasure for two states and may become a national or international treasure in the future. These data collection resources could become of international importance considering the effects of globalization and our emerging understanding of the connectedness of natural resources. The results of the WQMP program will be posted in the OLA and GMCG websites (http://www.ossipeelake.org/ and http://www.gmcg.org/).

Figure 2: Ossipee Lake and Tributary Sampling Sites

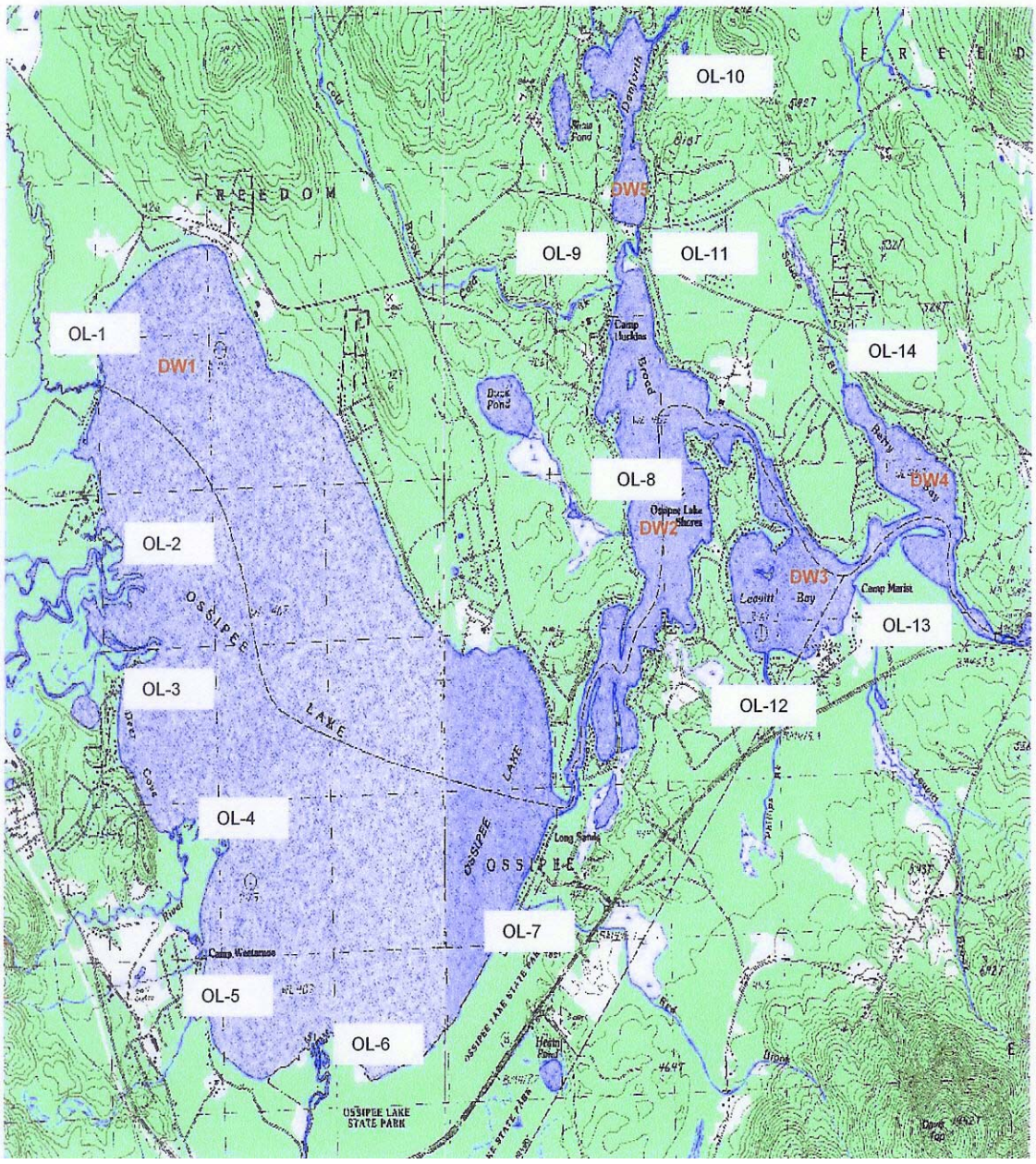


Figure 3: Depth Contour Chart of Ossipee Lake and Tributary Sampling Sites

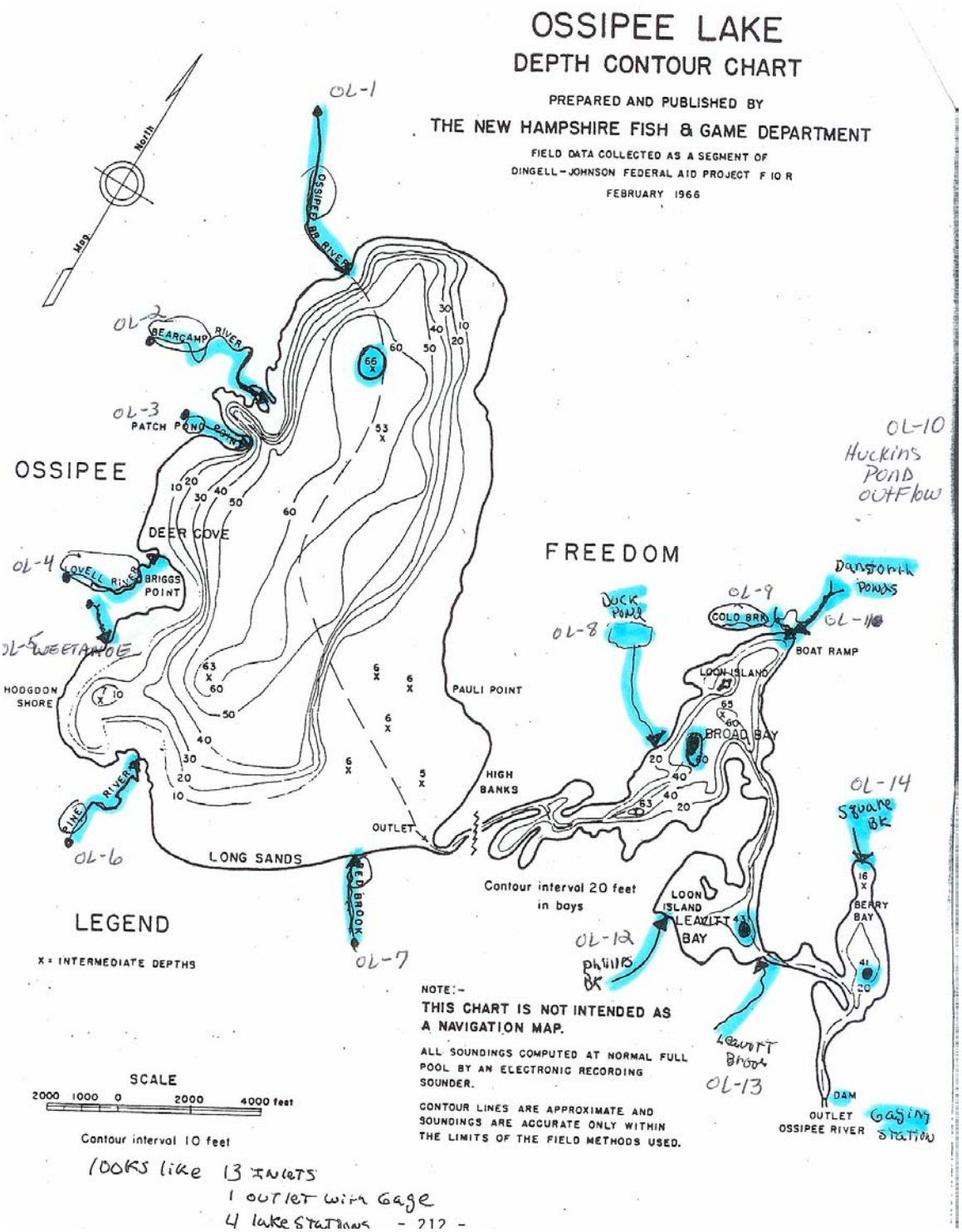


Figure 4: Depth Contour Chart of Upper Danforth Pond and Tributary Sampling Site

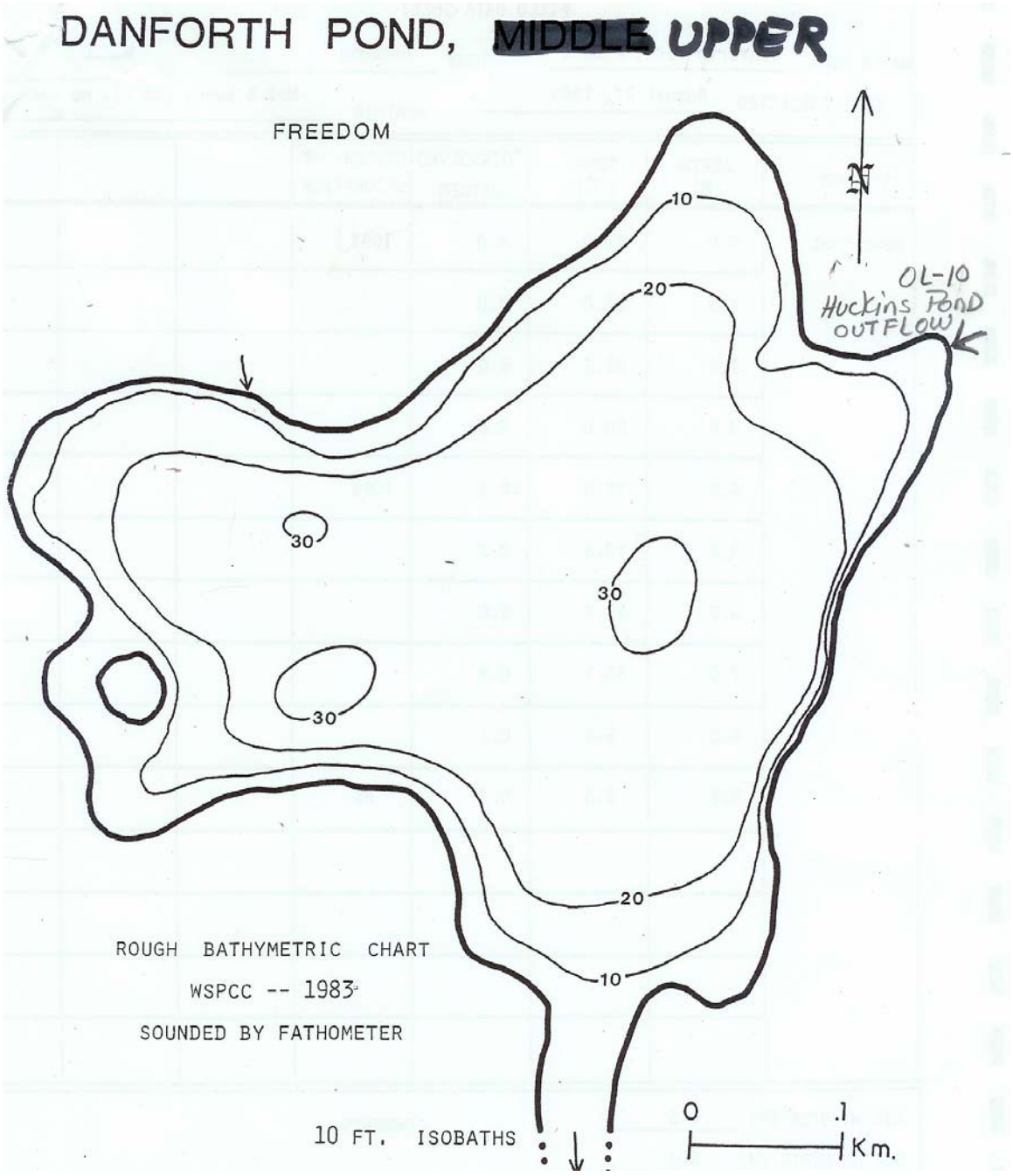
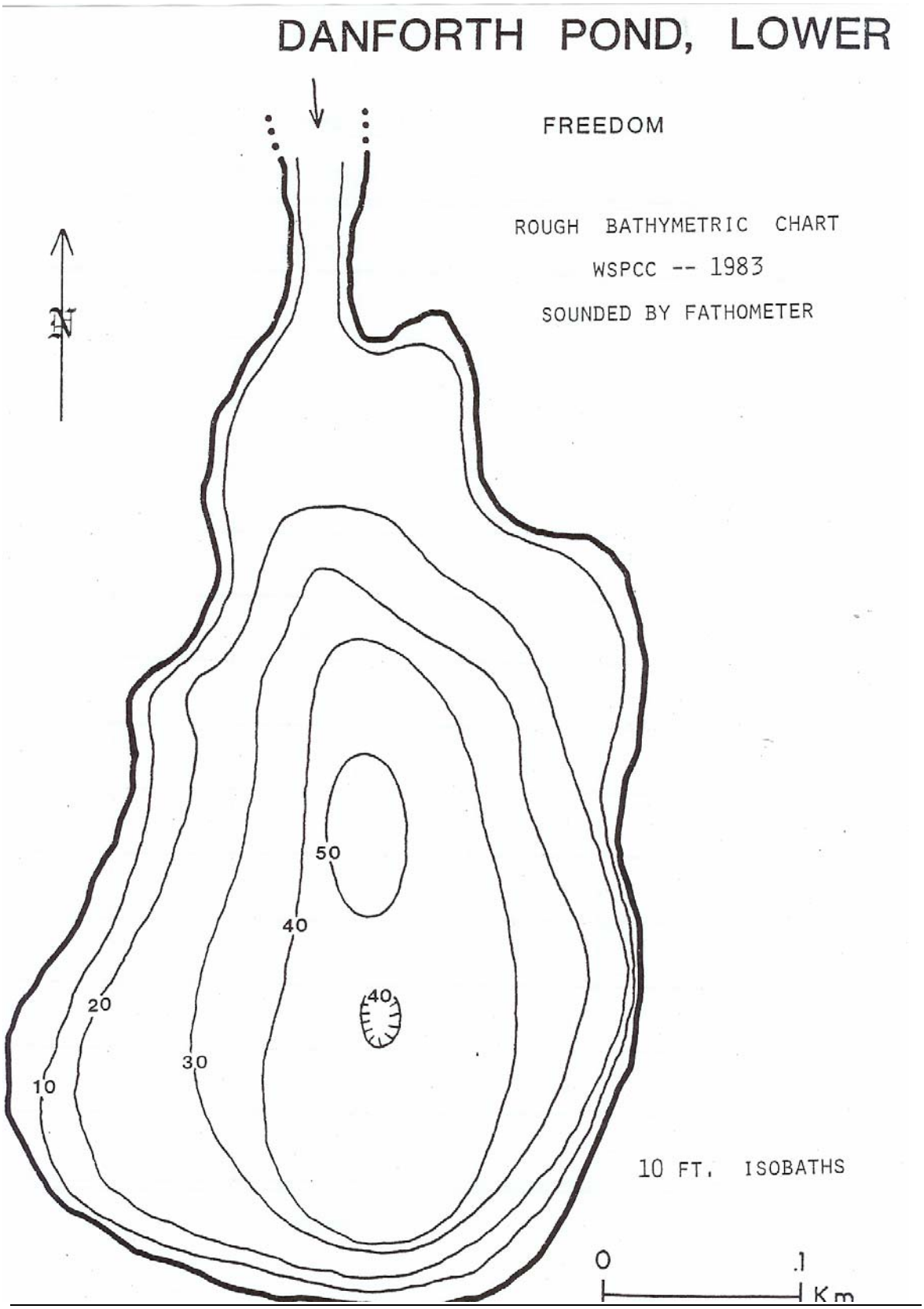


Figure 5: Depth Contour Chart of Lower Danforth Pond



6. PROJECT/TASK DESCRIPTION

Water Quality Management

Since the overall quality of the water in the Ossipee Lake system is primarily affected by human activities and land uses in the watershed, it is extremely important that all of the major tributaries be sampled during the first year of the program. Sampling the tributaries will help determine baseline water quality conditions and pinpoint where pollution may be occurring in the watershed.

Water quality data provide an understanding of how land use and underlying geological controls affect the water in our lakes, rivers and streams. Because we do not have past data or long-term background information to review, it is difficult to determine if current land use practices and lake management are negatively affecting the water quality. Compiling water quality data will help establish the effectiveness or harmfulness of specific lake and land use practices in maintaining good water quality. These determinations can further guide informed decision-making to protect the natural resources of Ossipee Lake and its tributaries. Parameters tested in tributary samples will include total phosphorus, pH, acid neutralizing capacity, conductivity, turbidity, water clarity, dissolved oxygen, temperature Dissolved Organic Carbon (or NPOC), Total Dissolved Nitrogen, and a number of cations and anions.

Sampling at the deepest spot of a lake is an important adjunct to the tributary testing because it provides a picture of the overall biological and chemical health of the lake ecosystem. Depending on the depth of the lake, during the summer the state's lakes typically stratify into two or three layers based on temperature. Due to the differences in the density and temperature of each of the layers, different biological and chemical reactions may occur which will affect water quality. Therefore, it is important to take samples from each layer of the lake. Parameters tested in "Deep Spot" samples will include total phosphorus, pH, acid neutralizing capacity, conductivity, turbidity, chlorophyll-a, water clarity, phytoplankton, dissolved oxygen and temperature.

To accomplish these goals, certain tasks must be accomplished. They are:

1 – Training
2 – Tributary Monitoring
3 – Deep Spot Monitoring
4 – Laboratory Sample Analysis
5 – Data Analysis
6 – Reports

1. Training – There are two different types of monitoring processes occurring for this study. As a result, training must be split between them. All volunteers will receive an initial overview of the projects being provided by GMCG. They will then receive specific training for the type of monitoring they will be providing. Quality control testing will be performed as part of the certification process after training.

The tributary monitors will have an indoor class that provides them with hands-on experience of what the equipment consists of and how the data sheet is to be filled out. They will then have, at

their first monitoring session, a QA/QC officer that will help them learn to use the equipment on a one–on-one basis and answer any questions they may have. A field guide will be provided to assist them.

The deep spot monitors will have a NH State biologist train them in all of the procedures they will use. This will be done from a boat and in the field at the all deep spots for data collection. The monitors will be able to use all of the equipment and practice with it to ensure that they are confident in its use after the biologist has gone. They will be provided with a field guide as well.

2. Tributary Monitoring – This type of monitoring includes basic monitoring techniques. Physical and chemical parameters will be monitored bi-monthly June through August at each site. A total of fourteen tributary sites will be sampled on four dates in 2003. A complete list of the parameters used can be found in Section 11, Table 9. The results will reflect summer conditions of low water levels and high temperatures. It is also the time of the heaviest use of the waterways. These conditions will create overall high levels of pollution compared to the rest of the year. This scenario provides researchers with hard data that can be used to identify the largest issues that affect the area today. Quality control checks will be repeated at the end of the monitoring sessions to ensure that high quality is continued throughout the process.

3. Deep Spot Monitoring – This type of monitoring includes many of the same parameters as the tributary monitoring, with a few modifications and added parameters. A complete list of the parameters used can be found in Section 11, Table 10. Each site will be monitored once monthly from June through August. Since lakes tend to stratify, each thermocline layer will be identified using temperature readings taken at regular intervals. Then samples will be obtained from each of the three layers for later analysis. This monitoring will be accomplished during the same three-month time period as the tributary monitoring, so that results will be comparable, and conditions will be the same.

4. Laboratory Sample Analysis – There will be two separate laboratories processing the samples. The UNH laboratory will process the tributary samples, and the NHDES laboratory will process the deep spot samples. For complete details, see the NHDES Limnology Center Laboratory Manual. Holding times for each parameter can be found in Section 11, Tables 9 and 10. Since samples will be obtained on different dates, by different people and be delivered to different locations, there is no chance of confusing them before delivery to the laboratories.

5. Data Analysis – Each laboratory will complete this task for their set of samples. After analysis is completed, each laboratory will send its results back to the GMCG office and they will be incorporated into the final report. The GMCG Water Quality Program Director will be responsible for combining all results from the different laboratories into one final report.

6. Reports – This task will be a conglomeration of efforts by the GMCG staff, OLA staff and the two laboratories. The GMCG and OLA staffs are responsible for the semi-annual and final reports. Each laboratory is responsible for its data reports and analysis. These will be included in the other reports as GMCG and OLA staffs see fit. The semi-annual report will be produced in September immediately after the sampling season. The final report will be produced in December, or as soon as all the results from the different laboratories have been received.

Table 4, below, shows the anticipated project timeline for the WQMP:

Table 4: WQMP Yearly Timeline

MAJOR TASKS	J	F	M	A	M	J	J	A	S	O	N	D
QAPP Preparation & Completion	X	X	X	X	X						X	X
Volunteer Recruitment & Training	X	X	X	X	X	X						X
Tributary Monitoring (bi-weekly, per site)						X	X	X				
Deep Spot Monitoring (monthly, per site)						X	X	X				
Quality Control Checks						X		X				
Laboratory Analysis						X	X	X	X	X	X	
Working Progress & Data Result Reports							X	X	X	X	X	
Semi-Annual Reports to NHDES									X			

Tributary testing in 2003 will begin the week of June 23 and end the week of August 8. All testing will be conducted prior to 9 AM. Testing needs to be completed in the early morning because as the day progresses, the sun increases the water temperature and the increased water temperature decreases the levels of dissolved oxygen. Therefore testing will be completed before 9 AM in order to obtain an accurate measurement of the dissolved oxygen.

All deep spot sampling events will be conducted between 10 AM and 3 PM to ensure accuracy and consistency and so that transparency can be determined. Prior to starting the sampling process, the WQM Coordinators will check the weather report since sampling should not occur during thunderstorms or when winds are excessive.

The first sampling event will be conducted by the NHDES VLAP Coordinator and will also serve as the training session for the WQM coordinators. NHDES will provide two sets of equipment for the first event. The WQM Coordinators will obtain equipment from NHDES for all subsequent events.

Table 5 shows the anticipated schedule for the WQMP tributary and deep-water sampling in 2003:

Table 5: Schedule of WQM Coordinators

Date	Coordinator	Sampling	Sites	Volunteers	Access
Thursday June 19	Sarah	Deep spot	DW-2 DW-3 DW-4	None –training session with VLAP coordinator	Boat
	Moselle	Deep spot	DW-1 DW-5	None –training session with VLAP coordinator	Boat
Monday June 23	Sarah	Tributary	OL-13*	Camp Marist	Boat
	Moselle	Tributary	OL-7, OL-14	None -- Moselle will do	Foot
Tuesday June 24	Sarah	Tributary	OL-1 OL-2	Camp Calumet	Boat
Wednesday June 25	Sarah	Tributary	OL-3 OL-4	Camp Calumet	Boat
	Moselle	Tributary	OL-5 OL-6	Camp Cody	Boat
Thursday June 26	Sarah	Tributary	OL-8 OL-12	Camp Robin Hood	Boat
	Moselle	Tributary	OL-9 OL-11	Camp Huckins	Boat
Friday June 27	Moselle	Tributary	OL-10	Camp Tokhomeupog	Boat
Monday July 7	Sarah	Tributary	OL-13	Camp Marist	Boat
	Moselle	Tributary	OL-7, OL-14	None -- Moselle will do	Foot
Tuesday July 8	Sarah	Tributary	OL-1 OL-2*	Camp Calumet	Boat
Wednesday July 9	Sarah	Tributary	OL-3 OL-4	Camp Calumet	Boat
	Moselle	Tributary	OL-5* OL-6	Camp Cody	Boat
Thursday July 10	Sarah	Tributary	OL-8 OL-12	Camp Robin Hood	Boat
	Moselle	Tributary	OL-9 OL-11	Camp Huckins	Boat
Friday July 11	Moselle	Tributary	OL-10	Camp Tokhomeupog	Boat
Monday July 14	Sarah	Pick up two sets of VLAP sampling equipment at DES in Concord			
Tuesday July 15	Sarah	Deep spot	DW-2 DW-3 DW-4	Camp Huckins Camp Marist	Boat
	Moselle	Deep spot	DW-1 DW-5	Camp Calumet Danforth Bay Campground	Boat

Date	Coordinator	Sampling	Sites	Volunteers	Access
	Moselle	Return VLAP sampling equipment to DES in Concord			
Monday July 21 and August 4	Sarah	Tributary	OL-13	Camp Marist	Boat
	Moselle	Tributary	OL-7* OL-14	None -- Moselle will do	Foot
Tuesday July 22 and August 5	Sarah	Tributary	OL-1 OL-2	Camp Calumet	Boat
Wednesday July 23 and August 6	Sarah	Tributary	OL-3 OL-4	Camp Calumet	Boat
	Moselle	Tributary	OL-5 OL-6	Camp Cody	Boat
Thursday July 24 and August 7	Sarah	Tributary	OL-8* OL-12	Camp Robin Hood	Boat
	Moselle	Tributary	OL-9 OL-11*	Camp Huckins	Boat
Friday July 25 and August 8	Moselle	Tributary	OL-10	Camp Tokhomeupog	Boat
Monday August 12	Moselle	Pick up two sets of VLAP sampling equipment at DES in Concord			
Tuesday August 13	Sarah	Deep spot	DW-2 DW-3 DW-4	Camp Robin Hood Camp Marist	Boat
	Moselle	Deep spot	DW-1 DW-5	Camp Calumet Danforth Bay Campground	Boat
	Sarah	Return VLAP sampling equipment to DES in Concord			

*Indicates a duplicate sample will be collected at this site. For duplicates shown on July 25 and August 8, only one duplicate will be collected at that site; the coordinators will decide on which of the two dates they will collect the duplicate.

OLA and GMCG anticipate continuing the WQMP beyond 2003. After a final report is made available on the current program, a decision will be made on how to proceed in 2004 and beyond.

Important water quality factors for the deep spot monitoring in the lake are provided in Appendix E. The tributary monitoring uses some of the same tests for the same reasons. Comparisons in the monitor parameters can be made by comparing Tables 9 and 10 in Section 11. In this type of monitoring, the temperature is not used to identify water layers, so only one measurement is taken. The nutrient monitoring is used to help identify what non-point source pollution issues are important to this particular system. Procedures that are not used for this tributary monitoring are secchi disk water clarity, ANC, conductivity, Chlorophyll-a and phytoplankton. If particular issues are identified in the lake with these procedures, experts (DES, UNH-CE, and others) will provide advice to help to the monitoring group decide how best to proceed in using them for tributary monitoring as well.

7. DATA QUALITY OBJECTIVES FOR MEASUREMENT DATA

Precision, Accuracy and Measurement Range

Duplicate precision is typically analyzed by calculating the relative percent difference (RPD) using the following equation. Monitors will use this equation for all of their precision calculations.

$$RPD = \frac{|x_1 - x_2|}{\left(\frac{x_1 + x_2}{2}\right)} \times 100\%$$

where x_1 is the original sample concentration
x_2 is the duplicate sample concentration

RPDs <20% will be deemed acceptable. Should consistent results of <15%RPDs occur in the first year, this limit may be reduced in future years.

The following table illustrates the precision, accuracy and measurement range for the parameters selected as part of the program. The laboratories that are processing the samples, where monitors are not providing the results, have provided all precision and accuracy limits. All laboratory calculations are provided in the laboratory SOPs.

Table 6: Tributary Monitoring Parameters

Parameter	Matrix	Reporting Units	Precision (+\-)	Accuracy (+\- %)	Measurement Range
Temperature	Water	Degrees Centigrade	10 %	0.3	-5 to 45
pH	Water	Standard Units	0.2 pH units	0.2	0 - 14
Dissolved Oxygen	Water	Mg/L and % Saturation	10%	1.0	0 – 20 mg/L (ppm) 0 – 200% saturation
Turbidity	Water	NTU's	10%	2.0	0 - 1000
Total Phosphorus - UNH	Water	µg/L	15%	10	3.0 - 200
NPOC or Dissolved Organic Carbon	Water	mg C/L	4.9%	3.0	0 – 20
Total Dissolved Nitrogen	Water	mg N/L	7.8%	2.1	0 – 10
Dissolved Organic Nitrogen	Water	mg N/L	10 – 15%	10	0 – 2.0
Ammonium	Water	µg N/L	7.1	5.0	0 – 200
Orthophosphate	Water	µg P/L	7.8	6.3	0 – 200
Silica	Water	mg SiO2/L	3.5	Not Given	0 – 40
Chloride	Water	mg Cl/L	1.6	7.3	0 – 15
Nitrate	Water	mg N/L	0.3	3.7	0 – 3
Sulfate	Water	mg S/L	2.2	13.5	0 – 8
Sodium	Water	mg Na/L	0.9	12.7	0 – 15
Potassium	Water	mg K/L	10.4	2.2	0 – 7
Magnesium	Water	mg Mg/L	4.5	10.3	0 – 7
Calcium	Water	mg Ca/L	4.0	1.8	0 – 10

As an indicator of measurement confidence, percent accuracy will be calculated based on analytical results of spiked samples of known chemical concentrations for TP, NPOC, TDN and all nutrient processing (except Silica, as there is no known spike used for that testing process). The following equation will be used:

$$\%Accuracy\ /\ Bias = \frac{SpikedSampleConc. - UnspikedSampleConc.}{SpikedConc.Added} \times 100\%$$

The following table illustrates the precision, accuracy and measurement range for the parameters selected for Deep Spot Sites. Qualified technicians provide the identification of phytoplankton

and results will not be compared using numbers. Monitors will not provide spiked samples, and will therefore not use this calculation for their results. Manufacturer data for the meters has been provided for the accuracy of these results, with the assumption that the meters are being operated within proper calibration limits.

Table 7: Deep Spot Monitoring Parameters

Parameter	Matrix	Reporting Units	Precision (+\- %)	Accuracy (+\- %)	Measurement Range
Temperature	Water	Degrees Centigrade	0.1	0.1˚C	-5 to 45
pH	Water	Standard Units	0.01 Units	0.1	0 - 14
Dissolved Oxygen	Water	mg/L and % Saturation	0.1	0.1	0 – 20 mg/L (ppm) 0 – 200% saturation
Turbidity	Water	NTU's	0.01	10	0 - 1000
Total Phosphorus - NHDES	Water	mg/L	0.001	10	0.005 - 0.121
ANC	Water	mg/L	0.1	Not Given	0 - 90
Conductivity	Water	μmhos/cm	0.01	10	13 - 700
Chlorophyll-a	Water	ug/L	0.01	Not Given	0 - 145
Secchi Disk Water Clarity	Water	Meters	0.1	Unknown	0 - 20.0
Phytoplankton	Water	N/A	N/A	N/A	N/A

Please refer to the SOP's for differences in the precision and accuracy results. Since the methods and techniques are different for sampling and obtaining results, precision and accuracy can vary widely between the two data sets.

Data Representativeness

Tributary Samples: The data will reflect the physical and chemical properties of the surface water taken at a depth of no less than 4 inches at each one of the data collection sites. Given the variables in site locations and water levels throughout the season, depths of samples can range between 4 to 16 inches. However, depths among the different parameters are kept in close proximity. It is expected that two measurements will be taken at each site. Individual sample sites were chosen to get a balanced view of the different flows into and out of the lake. These samples will be processed at the UNH laboratories. The results will be representative of summer low-flow conditions. Each tributary will be monitored four times per summer under a variety of weather conditions except during severe weather conditions such as thunderstorms and hurricanes.

Deep Spot Samples: The data obtained from these samples will provide an overall view of what is happening in each water layer of the lake. It will also show how each water body within the lake behaves in comparison to the others. This can be of significant importance to future testing and use of the lake. Since each water layer will be sampled, all dominant species of phytoplankton during these months are expected to be identified. The samples will be processed

at the NHDES Concord Laboratory. For complete information, refer to NHDES Limnology Center Laboratory Manual.

Data Comparability

Baseline data that are collected will be compared to future data sets and will be used to monitor any changes, or document any trends, that might be occurring in the lake. The data will also be compared to historical data where it exists, and to any local identified references. The Saco River Basin Water Quality Monitoring Program (Saco-Ossipee Project) data, a project that is happening concurrently, will be directly comparable to this study since the same program is being implemented for the tributary monitoring. Data from the methods that are similar between the Saco-Ossipee Project and the Deep Spot Sampling can be compared in this respect as well. The Deep Spot sampling methods used by this monitoring group are the same methods used in the New Hampshire Volunteer Lake Assessment Program (NHVLAP). The results from these procedures will be comparable to all other lake monitoring programs within the State of New Hampshire. Since the methods are based on the EPA Standard Methods, they should be comparable to national results as well. For more information about SOPs and reference material, see Appendixes A and B, the NHDES SOP's, and the reference section at the end.

Completeness

In order for the collected data to be used with confidence, there must be enough valid data. It is expected that at least 90% of the data collection will be completed. The results for the 2002 season for the SRBP were 98.57% Complete. The few pieces of missing data were mostly due to equipment failure. Similar results for completeness are expected for this program. Changes in the meters used for dissolved oxygen and pH might increases the completeness of the data for this project, but a different laboratory will be used for analyzing the deep spot samples. There are no legal or compliance requirements for this data, as it is providing baseline information.

8. TRAINING REQUIREMENTS AND CERTIFICATION

Tributary Monitoring
The WQM Director will train the Coordinators prior to the start of the sampling season. At the first training event, an overview of the WQMP will be provided so the coordinators understand their role in the program. They will be given the program's handbook with the SOPs and the testing parameters will be explained and reviewed.

In the OLPP project office, the Coordinators will be trained to prepare samples for laboratory analysis, to organize data in the database, and to maintain the equipment. Laboratory analysis preparations include filtering (using a 47 mm diameter 0.45 micron mesh size) and freezing samples for nutrients analysis and acidity using sulfuric acid, and freezing samples for phosphorus analysis. In the field at various tributaries, the Coordinators will be trained how to use the DO meter, the pH meter and the turbidity meter as well as how to gather water samples and record data on the field data sheet. Calibration training will occur prior to field training.

At their first sampling event, the Coordinators will go through a training process in which they use the meters and process the site while being supervised. The WQM Director will answer questions and walk the Coordinators through any steps they have difficulty with. Proper calibration is included in this first sampling event. When the WQM Director is satisfied that the Coordinators understand the process and can perform the sampling alone, they will be certified and they will receive a certificate of completion. Copies of such certificates will be kept on file at WQMP office.

Periodically throughout the monitoring season the WQM Director will evaluate the Coordinators' effectiveness by testing their proficiency in performing the monitoring procedures. Camp Volunteers will not be using the equipment and will not receive the training.

Deep Spot Monitoring
The NHDES VLAP Coordinator will train the WQM Coordinators on-site during the first deep spot sampling event. The VLAP Coordinator will demonstrate how to operate the Kemmerer bottle, the integrated tube and the Secchi disk and will then observe them using the equipment. The VLAP Coordinator will identify the location of each of the three lake layers (epilimnion, metalimnion, hypolimnion) based on the temperature readings.

The WQM Coordinators will also be trained how to collect a plankton sample by doing a vertical tow using a plankton net. The haul will start at the middle of the metalimnion and will extend to the surface. The sample will be put in a glass bottle, preserved with Lugol's solution (an iodine solution) and will be analyzed in the NHDES Limnology Center.

The VLAP Coordinator will teach the WQM Coordinators how to collect a sample using the integrated tube to collect the chlorophyll-a sample at the deep spot (from the mid-metalimnion up to the surface). All SOPs for these procedures are found in the NHDES Limnology Center Manual.

Each WQM Coordinator will observe and participate in all five such sampling sequences during the initial sampling event. When the VLAP Coordinator is satisfied that the WQM Coordinators understand how to operate the equipment and correctly gather the samples, the completion of the

training will be recorded. Later, the VLAP Coordinator will issue a letter of training completion to the WQM Coordinators, copies of which will be placed on file at the WQMP office.

The WQM Coordinators will be encouraged to refer to the training manual each time they sample during the season. Each year the VLAP Coordinator will visit the lake to assess the WQM Coordinators' ability to use the equipment and collect samples properly using the NHDES Annual Assessment Audit Sheet. If deficiencies are noted, the WQM Coordinators will be retrained.

During the second and third deep spot sampling events, the trained WQM Coordinators will instruct Camp Volunteers on the use of the Kemmerer bottle, the integrated tube and the Secchi disk so that they can participate in this part of the process. They will also be trained in the profile and plankton net procedures. The WQM Coordinators will have their handbooks and the NHVLAP Monitor's Guide on hand for reference as needed. Camp Volunteers who are trained in these procedures will receive a certificate of training completion from the WQMP at the end of the season.

The safety of participants is a prime consideration of the program, including ensuring ease of access to the sampling sites, ensuring that conditions are optimal for testing, and that participants are comfortable with the tasks required. OLA and GMCG personnel will sign a release form that confirms they know that they are performing sampling tasks, including boating, at their own risk and acknowledging their personal responsibility for knowing proper safety precautions on the water and exercising common sense and good judgment at all times. The participating camps adhere to the water safety criteria established by the Accreditation Committee of the American Camping Association. These criteria may be found in Appendix D. While WQMP personnel are using the camp boats they too are also expected to follow these safety rules.

9. DOCUMENTATION AND RECORDS

Coordinators will receive field data sheets printed on weatherproof paper and a suitable pen to record data. Field data sheets are filled out for each sample collected and submitted to the WQM Director at the end of each day.

Each sample that will be transported to a lab will receive a specialized label that will include information on the sample location, replicate number, time, date, identification number and sampler's name. Sample labels are shown below, as Figure 6.

Label information will correspond with the field data sheets (See Appendix E for Forms) that will be completed for each monitoring session. For the deep spot sampling, the WQM Coordinators will make a copy of the field data sheets for the WQMP's records before delivering them to the NHDES laboratory with the samples. The data sheet will inform the laboratory and GMCG of any unusual circumstances that were encountered in the field, such as extreme weather, near-by shoreline construction projects, algae blooms, water discoloration and the like. Tributary data sheets will also correspond with label information. The data sheet will note recent and current weather events, wildlife, water observations and disturbances. Data will be entered into a database each day it is collected. The data sheets will be stored in the GMCG office. Once a month during the summer, the Water Quality Program Director will check the data in the computer against the saved field data sheets.

The Chain of Custody (COC) will be filled out when the samples arrive at the WQMP office. WQMP personnel will relinquish all of the samples to the laboratory when laboratory personnel receive them. The COC will follow the samples to the laboratories and remain with the samples until they are used or disposed of. The WQMP will retain a copy of each COC after the laboratories have received the samples.

Once all fieldwork is completed, information on the field data sheets will be transferred to computer files in the WQMP office only after the WQM Director has inspected and signed off on each individual field data sheet. Although that information will be transferred to computer format, all field data sheets will be kept on file permanently to ensure that the data are always available in two forms. This computerized information will be included as part of the OLA and GMCG websites and will be disseminated to the communities affected by the program as well as through the press, either as a press release or a short feature. The reports will be released in the GMCG and OLA newsletters as well.

WQMP staff will keep a complete set of training, education, sampling data and volunteer records at the program's office for a minimum of five years.

Figure 6: Sample Labels for Tributary Bottles

Sample To Be Analyzed For Total Phosphorus at Deep Spot Sites:

Site Code:	Sample #:	Date:	Time:	Sampler:	Sample Type
DW-1	1A	3/3/03	3:33PM	E.Lindquist	Water

Preservative: Sulfuric Acid and <0 °c

Sample To Be Analyzed For Other Nutrients:

Site Code:	Sample #:	Date:	Time:	Sampler:	Sample Type
OL-1	1B	3/3/03	3:40PM	E. Lindquist	Water

Filtered through 47mm diameter 0.45 micron mesh Whatman filter
Preservative: frozen at <0 °c

The laboratories will complete analysis of the samples and keep raw data at their offices. A report for each laboratory will be sent to the GMCG office, which will include all of the QA/QC information for each laboratory with the monitoring results. Explanations will be made for any missing data when possible.

Deep water sampling bottles will receive a label that identifies the Lake, depth, date, time and sampler name. Total phosphorus bottles will be provided with a label that reads "DANGER ACID" because of the sulfuric acid that has been added by the NHDES Limnology Center to preserve the sample.

10. SAMPLING PROCESS DESIGN

Data Collection Tasks
Ossipee Lake's 14 tributaries will be sampled four times during the summer and the deep spots will be sampled once per month from June through August during the summer of 2003. The locations of the sampling events are shown in the maps on pages 11-14.

The sampling will be managed by the WQM Director and conducted by the WQM Coordinators accompanied and assisted by Camp Volunteers from the lake's six children's camps, as described in Section 4. Each Coordinator will be assigned to three camps and each camp will have a designated contact person for the WQMP. The Coordinators will meet their camp contacts and the campers at a designated time and place and will either walk to the test site or boat to the site to sample and process the water.

Tributary water samples will be collected from the center of each tributary at a spot within the tributary that is six feet from the point where it enters the body of the lake. At the two sites (OL-7 and OL-13) that are sampled by foot, samples will be collected at the side of the tributary. Tributary sites that are sampled further upstream than six feet will be marked with orange flagging to ensure that the same spot is sampled each time. This will be done once at each site. The precise sampling locations for all of the tributaries will be established prior to the start of the WQMP by WQMP staff and a representative of the UNH Cooperative Extension Service. On the day of the sampling, the Coordinators will meet their camp contacts at the camp with the sampling equipment, clipboards and field data sheets. At the completion of the tributary sampling process, the Coordinators will return the samples to the WQMP office where they will be frozen until they can be delivered to the UNH laboratory in Durham.

On the afternoon prior to the deep spot sampling, one of the WQM Coordinators will pick up the deep spot testing equipment from NHDES Limnology Center in Concord. On the day of the sampling, the Coordinators will meet their camp contacts at the camp boat with the sampling equipment, clipboards, and field data sheets. They will travel to the deep-water spot of the lake as identified by NHDES during the initial sampling and training session. The deep spot will be located through triangulation or by using a GPS device, if available. When the sampling has been completed, the samples will be kept cool using coolers and ice. One of the Coordinators will return the equipment and the samples to Concord within 24 hours. The samples will then be processed by NHDES. For complete information, refer to NHDES Limnology Center Laboratory Manual.

A duplicate sample will be taken at a rate of 10% during each sampling session, for both deep water and tributary sampling, to demonstrate the consistency of the sampling techniques. This sample will be processed in the same manner as all other samples of the same type, and the two sets of data for that time and location will be compared to determine how precise the results are.

The following describes the sites that are included in the 2003 WQMP:

Tributaries:

OL-1: Ossipee Brook River (West Branch River)

This river starts at the south end of Silver Lake and flows into Lily Pond adjacent to the International Paper mill on Route 41. From there it flows south and crosses Ossipee Lake Road, forming the boundary between Freedom and Ossipee. It enters Ossipee Lake between Babcock Road in Freedom and Nichols Road in Ossipee.

OL-2: Bear Camp River

This river originates in the town of Sandwich and follows Route 113 through the town of Tamworth, crossing under Route 16 south of West Ossipee. It passes the Gitchie Gumie Campground before entering the main body of Ossipee Lake north of Deer Cove.

OL-3: Patch Pond Point River

The tributary at Patch Pond Point begins as a pond behind the housing development at Deer Cove. The point at which the water flows into Ossipee Lake is on the north side of Deer Cove, south of Meadow Cove, which itself is south of the Bearcamp River "delta."

OL-4: Lovell River

This river originates at Connor Pond in the Ossipee Mountain Range and flows under Route 16 at the Indian Mound Golf Club. It enters the main body of Ossipee Lake south of Deer Cove at the site of a large housing development called The Bluffs.

OL-5: Weetamoe Brook.

This brook flows into the main lake at the former location of Camp Weetamoe, a Girl Scout summer camp that is now used for private rental cottages. The brook flows under Route 16, a major state highway, and through the Indian Mound Shopping Center and the Indian Mound Golf Course, two high impact land uses.

OL-6: Pine River

Pine River is one of the lake's major tributaries and has heavy daily recreational use that includes powerboats. It is the location of the only state boat ramp providing access to Ossipee Lake. From that location it flows under Route 25 and passes several clusters of homes before entering the main lake at its southern end, adjacent to the ecologically fragile Ossipee Lake Natural Area.

OL-7: Red Brook

This brook enters the southeast end of the main body of Ossipee Lake between Long Sands and the Ossipee Lake Natural Area. It flows from the Heath Bog, passing the commercial operations of South African Pulp and Paper Industries.

OL-8: Duck Pond

This river flows into the western side of Broad Bay on a peninsula between Broad Bay and Ossipee Lake, south of Camp Huckins. It runs through a pine forest with houses on both sides of a road that runs near it.

OL-9: Cold Brook

The headwaters of this brook are west of Trout Pond. It runs between Trout Pond and the Jackman Ridge along the Pequawket Trail and passes under the Ossipee Lake Road east of the Pequawket Trail. It subsequently enters the north side of Broad Bay between Camp Huckins and Ossipee Lake Marina.

OL-10: Huckins Pond Outflow.

This brook flows into Danforth Pond from Huckins Pond, which is undeveloped. Although there is some use of this tributary by fishing boats with small engines and, illegally, by personal watercraft, testing results from this location should serve as a control.

OL-11: Danforth Brook

Along with Pine River, this brook has the highest level of recreational use among the lake's tributaries. As the only water connection between Danforth Pond and Broad Bay it has substantial daily boat traffic. At its terminus with Broad Bay it passes two high impact land uses, Ossipee Lake Marina and the Ossipee Village Beach Club.

OL-12: Phillips Brook

This brook starts at Hanson Top and Davis Top coming off of the Green Mountain range. It crosses under Route 25 at Leavitt Road and enters Leavitt Bay, passing a housing development and campground near the point where it enters Leavitt Bay.

OL-13: Leavitt Brook

This brook starts at Hanson Top and Davis Top in the Green Mountain range. It crosses under Route 25 close to Camp Marist and enters the south end of Leavitt Bay between Leavitt Bay and the channel to Berry Bay on Camp Marist property.

OL-14: Square Brook

This brook flows into the northwest end of Berry Bay. It passes through the Square Brook housing development on the northeast side of Ossipee Lake Road, passes under that road before entering Berry Bay.

Deep Water Sites:

DW-1: Ossipee Lake - 66 feet
DW-2: Broad Bay - 60 feet
DW-3: Leavitt Bay - 43 feet
DW-4: Berry Bay - 41 feet
DW-5: Lower Danforth Pond- 40 feet

Note: The names of the waters comprising Danforth Pond vary from map to map. The WQMP uses the most common definition of Danforth Pond, which consists of the two bodies of water closest to Broad Bay. The one closest to Broad Bay is known as lower Danforth and the one furthest away is called upper Danforth.

The results from the sampling events will dictate where future sites will be located. It is unlikely that new tributaries will be discovered, but underground flows may prove to be of interest and river channels may move. Each water body has several deep areas that could be sites in future studies. A good baseline study will repeat its original sites for a number of years to see what parameters are changing versus staying the same.

Depths at the deep spots in the Ossipee Lake system are not proven in any of these bodies of water. The charts being used to locate them are over 40 years old, and there are no newer reports available. Depth is a parameter that may be added to this study for a more complete understanding of what is happening under the surface layers.

Severe weather may cause dangerous situations in which sampling will be delayed and re-scheduled. Camp safety rules will be followed in the event of rough weather for boating (See Appendix D). However, a variety of conditions during sampling events may show the buffering capacity of the lake for various parameters. Three dry months have been chosen for this study so that baseline conditions can be understood. Inflow from storm events will be noted in the data but will be considered normal should they occur.

Table 8: Breakdown of Expected Sample Collections

Site ID	Parameters Measured in the Field	Laboratory Samples	Number of Times Sampled per Year	Samples Expected
Tributaries	Temperature pH Dissolved Oxygen Turbidity	In UNH lab: DOC, TDN, DON, NH_4^+, TP, Ortho-P, Si, Cl, NO_3, SO_4, Na, K, Mg, Ca	4	14 Sites x 4 Times + 7 Duplicates = 63
Deep spot	Temperature*, Dissolved Oxygen*, Clarity	In DES Limno lab: ANC, Conductivity, Chlorophyll-a, Phytoplankton, pH, Turbidity In DES Laboratory Services Unit: TP	1 for ANC, conductivity, chlorophyll-a, pH, TP, and Turbidity; 3 for phytoplankton	5 sites x 1 time + 2 duplicates = 7 5 Sites x 3 Times + 2 Duplicates = 17

*Dissolved Oxygen and Temperature measurements will only occur during June when the DES biologist trains coordinators to use the other equipment.

11. SAMPLING METHODS REQUIREMENTS

Refer to the Standard Operating Procedures (SOPs) in Appendixes A and B and the NH DES Limnology Center Laboratory Manual for detailed information regarding how samples will be taken, equipment and containers used, sample preservation methods used, and holding times. Tables 9 and 10 provide a summary of the information contained in the SOPs.

All equipment will be rinsed thoroughly with distilled water before a sampling event begins and between each sampling. This will ensure that there will be no cross-contamination between sites. All equipment will also be rinsed with the site water to be sampled so that dilution from the rinse water will not interfere with accurate results.

At the deep spot site on the annual training visit in June, the VLAP Coordinator will train the Coordinators in all of the sampling techniques required for this monitoring process (See Section 8). The WQM Coordinators will demonstrate to the campers and counselors how to collect the water samples for pH, turbidity, conductivity, total phosphorus and nutrients. Sample bottles will be filled, put on ice and then brought to the NHDES Limnology Center where they will be tested. The Coordinators will responsible for collecting the plankton and chlorophyll-a samples in the same water column zones.

At tributary sites, coordinators will sample for pH, turbidity, dissolved oxygen and temperature. Water samples will be collected in two bottles (acid washed by UNH) and analyzed by UNH for phosphorus and other nutrients (Table 9). Upon arrival at the GMCG office, one sample bottle will be preserved with 1 ml sulfuric acid and frozen. The second bottle will be filtered and frozen.

All sampling results will be entered into a computerized database spreadsheet and analyzed. The WQM Director will supervise the entry of all data. The tributary data will then be analyzed by UNH laboratory personnel and the deep spot data will be analyzed by the NHDES. UNH will provide acid washed bottles for tributary sampling. One milliliter of sulfuric acid is added to tributary samples to be analyzed for total phosphorus and samples are frozen. All tributary nutrient samples are filtered in the GMCG office using a 47mm diameter 0.45 micron mesh Whatman filter. Sixty milliliter bottles are rinsed three times with filtered sample and the bottle is filled with filtered sample. Sample is frozen immediately after filtering. To check for contamination in the filter or acid, two blanks using distilled water will be analyzed. The first blank will be acidified, frozen and analyzed for total phosphorous. The second blank will be filtered, frozen and analyzed for other nutrients (Table 9). These blanks will be included in shipment to the UNH laboratory.

These data will be compared to data collected during previous years if such data are available. Any inconsistencies with the data or field data sheets will be identified and explanations will be provided where possible. Data entry QA/QC checks will occur randomly during the data entry process. A short report of raw data will be produced and distributed to OLA, GMCG and the participating camps, providing a quick turnaround snapshot of the summer's accomplishments. A comprehensive report will be provided to the camps, local municipalities and other groups in order to increase public understanding of the program's goals and importance, and to underscore

the implications of the results. The final report will be available for inspection on the OLA and GMCG websites.

Table 9: Tributary Sampling Methods Requirements

Parameter	Matrix	Sampling Method	Sample Container	Preservative	Holding Time (Max)
Temperature	Water	Non-mercury Thermometer and YSI 60 Portable pH Meter	None, measurement taken in water	None	Immediately
pH	Water	YSI 60 Portable pH Meter	None, measurement taken in water	None	Immediately
Dissolved Oxygen	Water	YSI 550A Portable Dissolved Oxygen Meter	None, measurement taken in water	None	Immediately
Turbidity	Water	2100P Portable Turbidimeter	None, measurement taken in water	None	Immediately
Total Phosphorus – UNH	Water	UNH Surface Water Sampling Method.	2 – 250 ml plastic sample bottles, screw top	Sulfuric Acid and Frozen	1 week on ice
Dissolved Organic Carbon	Water	NHVLAP Tributary Sampling Method	2 – 250 ml plastic sample bottles, screw top, filtered using a 47mm diameter 0.45 micron mesh Whatman filter into a 60 ml plastic bottle with a screw top.	Frozen	1 month on ice
Total Dissolved Nitrogen	Water	NHVLAP Tributary Sampling Method			1 month on ice
Dissolved Organic Nitrogen	Water	NHVLAP Tributary Sampling Method			1 month on ice
Ammonium	Water	NHVLAP Tributary Sampling Method			1 month on ice
Orthophosphate	Water	NHVLAP Tributary Sampling Method			1 month on ice

Parameter	Matrix	Sampling Method	Sample Container	Preservative	Holding Time (Max)
Silica	Water	NHVLAP Tributary Sampling Method			1 month on ice
Chloride	Water	NHVLAP Tributary Sampling Method			1 month on ice
Nitrate	Water	NHVLAP Tributary Sampling Method			1 month on ice
Sulfate	Water	NHVLAP Tributary Sampling Method	2 – 250 ml plastic sample bottles, screw top.	Frozen	1 month on ice
Sodium	Water	NHVLAP Tributary Sampling Method			1 month on ice
Potassium	Water	NHVLAP Tributary Sampling Method			1 month on ice
Magnesium	Water	NHVLAP Tributary Sampling Method			1 month on ice
Calcium	Water	NHVLAP Tributary Sampling Method			1 month on ice

Table 10: Deep Spot Sampling Methods Requirements

Parameters	Matrix	Sampling Method	Sample Container	Preservative	Holding Time (maximum)
Temperature*	Water	YSI 52 Portable Dissolved Oxygen Meter	None, measurement taken in water	None	Immediately
Dissolved Oxygen*	Water	YSI 52 Portable Dissolved Oxygen Meter	None, measurement taken in water	None	Immediately
Secchi Disk Water Clarity	Water	NHVLAP Deep Spot Sampling Method	Secchi Disk and Calibrated Chain	None	Immediately
pH	Water	Kemmerer Bottle	1000 ml translucent white plastic Nalgene sample bottle	None	24 Hours
Turbidity	Water	Kemmerer Bottle	1000 ml translucent white plastic Nalgene sample bottle	None	24 Hours
Total Phosphorus – NHDES	Water	Kemmerer Bottle	Small brown, opaque phosphorus bottle 250 mL, Nalgene	Sulfuric Acid	24 Hrs. Return to Laboratory, 21 days
ANC	Water	Kemmerer Bottle	1000 ml translucent white plastic Nalgene sample bottle	None	24 Hours
Conductivity	Water	Kemmerer Bottle	1000 ml translucent white plastic Nalgene sample bottle	None	24 Hrs. Return to Laboratory, 28 Days
Chlorophyll-a	Water	Integrated Sampling tube	Dark amber bottle, 1000 mL Nalgene	Unfiltered, Dark, 4°C	24 Hours
Phytoplankton	Water	Sample water collected with plankton net	Small glass 250-mL jar	Lugol's Solution In 4°C	24 Hrs. Return to Laboratory, 3 months

*Dissolved Oxygen and Temperature measurements will only occur during June when the DES biologist trains coordinators to use other equipment.

Equipment checklists are provided in Appendix C.

12. SAMPLE HANDLING AND CUSTODY PROCEDURES

Sample containers will be marked with identification labels (See Figure 6) that will be matched to the identification information on the field data sheets (See Appendix E for Forms). Samples requiring transport to UNH will be frozen within eight hours of sample collection until scheduled transport by a courier. Samples requiring transport to the NHDES Laboratory Services Unit in Concord will be contained in a cooler at a temperature of about 4°C and delivered within 24 hours by a WQM Coordinator. These samples will not go to the GMCG office and will be obtained on different dates, so there is no chance of confusing the samples.

The COC procedure will require that samplers fill out the COC when they return to the office. They will record on the COC each sample's date, time, sampler name, site number, number, type, and preservative method. All transfers will be recorded on the COC with the date and time of the transfer and the names of the personnel making the transfer. This will ensure that each person handling the sample will have signed the chain of custody form. See Appendix E for an example of this form. After the laboratory has received the samples, a copy of the completed COC will be provided to the WQMP for filing.

All samples, except for the deep spot Total Phosphorus, are preserved only with cold. Therefore, all other samples not required for analysis may be disposed of in a proper sewer system. Extra Total Phosphorus samples must be transported to the laboratory for proper disposal of acid solutions.

For laboratory sample handling at the UNH Laboratories, please see "QAPP for the Water Quality Analysis Lab at the University of New Hampshire, Department of Natural Resources, Durham, NH in Appendix B.

13. ANALYTICAL METHODS REQUIREMENTS

The analytical methods that will be used for temperature, pH, and dissolved oxygen come from the operation manuals for the YSI meters. The turbidity method comes from the operating manual published by HACH for the 2100P portable Turbidimeter. All of the field meter methods come from the EPA document #EPA 841-B-97-003 entitled "Volunteer Stream Monitoring: A Methods Manual." Protocols for non-purgeable organic carbon, total dissolved nitrogen, dissolved organic nitrogen, ammonium, phosphate, silica, chloride, nitrate, sulfate, sodium, potassium, magnesium, and calcium, are closely followed by the University of New Hampshire Water Resources Research Center Labs where the SOP's are kept in hardcopy and in digital file.

Data that is gathered by NHDES through the VLAP program will be analyzed by the VLAP Coordinator. For complete details, see the NHDES Limnology Center Laboratory Manual. Total phosphorus data from tributary sampling will be analyzed by Bob Craycraft of UNH Cooperative Extension. Other nutrient data from tributary sampling will be analyzed by Jeff Merriam of the UNH Water Resources Research Center Laboratory. The GMCG Water Quality Program Director will analyze and collaborate all data collected.

The summary for these procedures can be found in Table 11 below. The attached SOP's provide further detail regarding procedures used for collecting data, equipment use, and calibration, inspection, and maintenance of the instruments.

Table 11: Equipment and Methods used for Sample Analysis

Parameter	Equipment	Method
Temperature	YSI 60 Portable pH meter	EPA 841-B-97-003 Volunteer Stream Monitoring: A Methods Manual
	Non-mercury pocket thermometer	Used as a reference and not calibrated
Turbidity	Hach Patented Ratio™ Optics 2100P Portable Turbidimeter	EPA 841-B-97-003 Volunteer Stream Monitoring: A Methods Manual
pH	YSI 60 Portable Meter	EPA 841-B-97-003 Volunteer Stream Monitoring: A Methods Manual
Dissolved Oxygen	YSI 550A Portable Meter	EPA 841-B-97-003 Volunteer Stream Monitoring: A Methods Manual
Anions (Chloride, Nitrate, Sulfate = Cl, NO_3^-, SO_4^{-2})	Ion Chromatograph with suppressed conductivity detection	EPA Standard Method #300.1
Cations (Sodium, Potassium, Magnesium, Calcium = Na^+, K^+, Mg^{+2}, Ca^{+2})	Ion Chromatograph with conductivity detection	Ion chromatography with conductivity detection using an Alltech Universal Cation Column (P/N 27106) with a dilute nitric acid/EDTA mobile phase,
Dissolved Organic Carbon (DOC)	Shimadzu TOC-V carbon analyzer	High Temperature Catalytic Oxidation (HTCO), or sometimes High Temperature Oxidation (HTO) EPA Standard Method #415.1
Total Dissolved Nitrogen (TDN)	Shimadzu TOC-V carbon analyzer with a Chemiluminescent Nitrogen detector	J.L. Merriam, W.H. McDowell, and W.S. Currie. 1996. A High-temperature oxidation technique for determining total dissolved nitrogen. Soil Science Society of America Journal 60:1050-1055.

Parameter	Equipment	Method
Ammonium (NH_4^+)	Lachat Instruments QuikChem AE	EPA Standard Method #350.1
Soluble reactive phosphate (aka SRP, or orthophosphate, PO_4^{-2})	Lachat Instruments QuikChem AE	EPA Standard Method #365
Silica (SiO_2)	Lachat Instruments QuikChem AE	*Standard Methods for the Examination of Water and Wastewater*, 18th Edition, 1992, American Public Health Association, 1015 Fifteenth Street NW, Washington, D.C. 20005
Total Phosphorus - UNH	Milton Roy 1001+ Spectrophotometer	Standard Methods for the Examination of Water and Wastewater (20th edition); 4500-P E. Ascorbic Acid Method
Total Phosphorus - NHDES	Lachat QuikChem Method 10-115-01-1-F Total Phosphorus in Persulfate Digests	Standard Methods for the Examination of Water and Wastewater (20th edition); 4500-P E. Ascorbic Acid Method
ANC	Beckman Meter, Model 220	Standard Methods 20th Edition, 1998. 2320B
Conductivity	Orion Meter, Model 162A	Standard Methods 20th Edition, 1998. 2510B
Chlorophyll-a	SCUFA Spectrometer	Standard Methods 20th Edition, 1998. 10200H EPA 446.0
Secchi Disk Water Clarity	Secchi Disk with Calibrated Chain	NHVLAP Monitor's Guide
Phytoplankton	Binocular Dissecting Microscope & Phase Contrast, Compound Series Microscope	Standard Methods, 15th Edition, Pg., 912 – 914 & 942 – 947. and NHDES Limnology Center Method

14. QUALITY CONTROL REQUIREMENTS

Replicate readings for all meter-tested parameters are taken at each monitoring session to ensure the precision of the readings. Accuracy is ensured by proper calibration of the equipment before sample testing is implemented. When duplicate samples are taken, the laboratories will be expected to process them normally as a regular sample. The duplicate results will be compared in the analysis for QA/QC purposes. Distilled water samples will also be utilized and treated as a usual sample. One distilled water sample will be acidified, frozen and analyzed for phosphorus. Another distilled water sample will be filtered, frozen and analyzed for non-purgeable organic carbon, total dissolved nitrogen, dissolved organic nitrogen, ammonium, phosphate, silica, chloride, nitrate, sulfate, sodium, potassium, magnesium, calcium and total phosphorus.

Quality control for parameters processed at the UNH laboratory is as follows: Each processing run includes a blank and a duplicate are processed every 10 – 15 samples, and at least one spike per processing run at the UNH Laboratory. A multi-point calibration curve (4-7 points) will be analyzed at the beginning and the end of each run. These parameters include; non-purgeable organic carbon, total dissolved nitrogen, dissolved organic nitrogen, ammonium, phosphate, silica, chloride, nitrate, sulfate, sodium, potassium, magnesium, calcium and total phosphorus.

Total Phosphorus processing at the NHDES Laboratory will have the first sample of every eight (one set) duplicate tested and every fifth sample of each set will be spike tested.

Quality control for GMCG parameters (dissolved oxygen, pH, turbidity, and temperature) include replicate results at each sampling event, training records for samplers, random spot checks and data entry checks by the WQM Director.

As another form of quality control, DO and pH meters are calibrated at the beginning of each testing day by the Coordinators and again on the same day if the same meter is used to obtain more than three results in a row. Turbidity meters are checked for proper calibration at the same times but are only calibrated monthly unless checks show the meter to be outside the calibration limits. The WQM Director will oversee all field data sheets and perform periodic on-site reviews to monitor the Coordinator's knowledge of testing procedures.

Laboratory testing QA/QC samples and processes at both laboratories can be found in the SOPs in Appendix B and in the NHDES Limnology Center Laboratory Manual.

Should problems in accuracy or precision occur, the data related to the problem will be identified and program staff will attempt to identify the origin of the problem and resolve it before more data are lost.

15. INSTRUMENT & EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

The WQMP owns and maintains its own equipment for tributary testing. All field analytical instruments are inspected at the beginning of each testing week prior to being released for field work and are re-inspected when returned to the office at the conclusion of the testing day by the Coordinators. Any problems with the meters or equipment are logged for reference in the equipment maintenance logbook. The Coordinators are required to report problems to the WQM Director and Executive Directors for instructions on handling the problem. See Appendix C for an example from the equipment maintenance logbook. Logbooks are stored at the WQMP office.

NHDES will provide the deep spot testing equipment. It is expected to be clean and in proper working order when it is received and it is the responsibility of the Coordinator picking it up to inspect it and approve of it before leaving the Concord office. This method will prevent wasted time and will help protect the value of the equipment by identifying problems early.

Equipment will be returned clean and in proper working order. If there are problems with the equipment, the Coordinator will record them in the logbook and report them to the WQM Director. Back-up equipment for emergency replacement is not currently available. Extra sampling bottles will not be distributed. If a bottle is lost or a meter does not work, the sample and data for that portion will not be collected.

16. INSTRUMENT CALIBRATION AND FREQUENCY

The pH and dissolved oxygen meters are calibrated at the beginning of each testing day and again on the same day if the same meter is used to obtain more than three samples in a row. Temperature is obtained through the use of the pH meter, so if that meter calibrates correctly, it is assumed that the temperature is calibrated as well. The Turbidimeter is designed by the manufacturer to be calibrated using primary standards once every three months and by the use of secondary standards monthly. The WQM Director will be responsible for calibrating the Turbidimeter at the beginning and end of each sampling season and may do so more often if needed.

See Appendix E for an example page from the Calibration Logbook, which is stored at the WQMP office. For equipment that is calibrated before each sampling session, please see the field data sheet, also found in Appendix E. The field data sheets will contain all calibration records for each sampling event.

Detailed calibration procedures are contained in the SOP's included in Appendix A for all testing parameters. For the deep spot sites there are SOPs in the NHDES Limnology Center Laboratory Manual.

17. INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES

All supplies, with the exception of sample collection bottles, will be purchased from reliable laboratory suppliers and inspected for defects, broken seals, expiration dates, etc. All serial numbers will be checked and compared to certificates and logged for future reference. All supplies, including instruments and equipment will be checked regularly and during random field audits. Bottles that will be used to collect samples for the following parameters will be provided by UNH; non-purgeable organic carbon, total dissolved nitrogen, dissolved organic nitrogen, ammonium, phosphate, silica, chloride, nitrate, sulfate, sodium, potassium, magnesium, calcium, and total phosphorus. These bottles will be acid washed by UNH.

Supplies include; probes, bottles, batteries, thermometers, freeze packs and coolers. All bottles will be checked for cracks upon receipt, and rinsed (except for the deep spot TP bottles) with sample water before use. Probes will be inspected visually, then attached to the equipment and tested for acceptable results. Batteries will be replaced each year or voltage checked at the start of each season to ensure proper meter performance. Thermometers will not have any breaks or bubbles inside the capillary columns. Freeze packs will be checked for leakage and resealed or disposed of before each use. Coolers will be kept clean and will be inspected for proper closure.

Other minor supplies will include water resistant paper and writing utensils. Field data sheets will be printed on paper approved by the WQM Director, who will also provide writing utensils that write clearly on the specialized paper.

It will be the responsibility of the NHDES to provide initial inspections of their equipment before delivering it to WQMP personnel.

18. DATA ACQUISITION REQUIREMENTS

A program this extensive has never been undertaken in the Ossipee Lake basin. Given that fact, there are a variety of information sources that will be used to obtain both present and historical information on the area. Those data sources include:

- ≈ USGS 7.5 Minute Topographic Maps will be used for site locations and project boundaries.

- ≈ Climatological data will be obtained from the observations of the Coordinators. Scientifically collected data may be obtained from local weather stations if required. Rainfall amounts will be collected at the end of each sampling season to supplement the field sheet data.

- ≈ Habitat surveys will be completed by participants during the 2003-monitoring season.

- ≈ The GMCG & SRCC Water Quality Report, 2002, includes important water quality information for some of the tributaries and the area surrounding the lake.

- ≈ The Ossipee Lake Depth Contour Charts of Ossipee Lake, Upper Danforth Pond and Lower Danforth Pond; New Hampshire Fish and Game Department (NHF&G), 1966. (See Figures 3-5).

The first source is considered as reliable as possible, as the small changes that may occur in topography are unlikely to be significant to this study. Climatological data from participants in the study are considered reliable enough. If specific amounts of rainfall, cloud cover, or other factors become apparent as important influences, however, local weather stations will be able to provide both historical and current data. The water quality report is also very reliable and is completely comparable to the tributary testing.

The age of the Depth Contour Charts from the NHF&G shows that they may no longer be accurate. Samplers may find that maximum depth has decreased, increased or moved from where these charts indicate. It may be of interest to record maximum depth at each of these locations to have a better idea of current conditions.

19. DATA MANAGEMENT

The field data sheets and sample labels will be certified as complete and accurate by the Coordinators after each day of sampling. Completed data sheets will be submitted to the WQM Director for final inspection. If the Director finds any questionable information on the sheets, she will contact the appropriate Coordinator to discuss the situation and tag the sample, if necessary. If the field data sheets have been done correctly, the Director will sign-off on the data sheet once quality control has been completed. All numerical data on the sheets will be entered into a computerized Microsoft Excel spreadsheet under the supervision of the WQM Director. The computerized data will be doubled checked by at least one other person as a form of quality control.

Copies of the completed COCs will be obtained before the next sampling cycle is started and filed with the original data sheets for each sampling session. Results obtained from the laboratory will then be entered into the computer into the same Excel spreadsheet program. Again, all computer entries will be double checked by the Director before the data are accepted.

All reports, QAPPs, SOPs, handbooks, logbooks and other documents will be filed at the WQMP office, including copies of the COCs and field data sheets. Original COCs may be kept by the laboratories for their records.

Records of training, Camp Volunteer time and actions will be recorded at the WQMP office. In the future, should OLA and GMCG begin to work independently of one another, the records of the 2003 program will be kept at the most appropriate office. All of the time and work expended on the WQMP will be included in the final report.

20. ASSESSMENT AND RESPONSE ACTIONS

Attention to quality is a primary consideration of the program. The WQM Director will formally review the performance of the Coordinators at the mid-point in the season to ensure that samples are properly collected. All personnel associated with the program will ensure that the SOP's will be followed closely. Training, calibration, maintenance and laboratory records will be filled out in a timely manner. Refresher courses for the Coordinators may be required for each new season.

Equipment errors may occur and must be accounted for by reporting them to the WQM Director. If the error is identified before sampling takes place, the equipment will be labeled as broken and will be replaced by properly working equipment, if available. If malfunctioning equipment affects the data, the equipment will be recorded as such on the field data sheet and immediately reported to the Director.

Laboratories will be required to provide quality data. Missing data and data results falling outside of QA/QC guidelines must have satisfactory explanations before the data is accepted. Any data with out QA/QC validation will not be used for analysis.

21. REPORTS

The raw data from testing, without analysis or assumptions, will be made available to the program's participants and town officials in Freedom, Ossipee, and Effingham, and will be posted on the OLA and GMCG websites.

A semi-annual report will be produced and distributed by the end of September, or as soon as data have been received from all labs. The final report on the program will include all of the accepted data, explanations for unaccepted data, a complete analysis, and any other important information the organizers of the program feel is appropriate. The report will credit everyone who has worked on the program and provide a bibliography of resources used. The final report will be completed in December, provided that all data has been received from all labs. Semi-annual and final reports will be submitted to DES.

UNH and NHDES personnel will provide the analyses of the data and the WQM Director will be responsible for writing the remainder of the report under the direction of the Executive Directors. The final report will be mailed to the persons listed in Table 1 and will be posted in the same places as the raw data reports.

22. DATA REVIEW, VALIDATION, AND VERIFICATION

All field and laboratory data will be reviewed by the Executive Directors, WQM Director, and the Coordinators to determine if the data meet QAPP objectives. Decisions to reject or qualify data will be made jointly by the Executive Directors and WQM Director. It will be the responsibility of the UNH and NHDES laboratory managers to establish whether the data are acceptable based on instrument performance, and they may elect to disqualify data based on "wild" results. It will be the responsibility of the Executive Directors and the WQM Director to determine if the data are acceptable according to the program's quality objectives.

Laboratory explanations for eliminated data must be given to the Executive Directors and WQM Director prior to the analysis of the data. If analysis indicates that some data may be invalid, that statement must be included in the report with an explanation.

23. VALIDATION AND VERIFICATION METHODS

The WQM Director and Coordinators will perform the following tasks to ensure validity of all data associated with the program.

- ≈ Replicate samples of each meter-tested parameter on site, and every 10 samples sent to the laboratory, will have their results compared for precision. If an error of greater than 20% is found, the program staff will attempt to identify the problem and correct it. If human error is found to be the issue, the WQM Director will re-train the Coordinators. If equipment failure is the issue, attempts to repair the equipment will be made or the equipment will be replaced. If the source of the error cannot be found, the Executive Directors will consult specialists to resolve the problem.

- ≈ Field data sheets will be double-checked as soon as they are returned to the office. If errors are found, they will be corrected before computer data entry begins. If consistent errors are found, re-training on the particular issue will occur before the next sampling session.

- ≈ Equipment inspections will occur regularly to ensure that equipment is in proper working order. Multiple staff will be performing these inspections and records will be kept in the maintenance logbook and on the field data sheets when issues are found. If a piece of equipment is found to have a problem, qualified staff will verify the problem before corrective actions are taken.

- ≈ All data entered into the computer will be proofed by a second person for validation and to make corrections as needed.

24. RECONCILIATION WITH DATA QUALITY OBJECTIVES

Calculations and determinations for precision, accuracy and completeness will be made following each sampling season. If these data quality objectives are not met, the data will be tagged and subsequent corrective actions, taken in the next sampling season, will depend on the nature of the incident.

Since there are no equivalent prior studies completed in this area, there are no anticipated results for these data. Over time, the data collection may provide better data quality objectives when approximate ranges and expected conditions can be identified. For now, only precision, accuracy and completeness can be relied upon for solid objectives.

In situations where the equipment has been shown to be faulty it will be replaced or another method will be found. If it is shown that better training is required, the WQM Director may request additional support from UNH and NHDES to ensure that training has been completed properly. The laboratories have past records that show all of their data quality objectives are expected to be met.

25. REFERENCES:

1. Welcome to the Rivers Program Regional Interstate Volunteers for the Ecosystems and Rivers of Saco, by Brianne Fowles, Elisha Lindquist and Lynn M. Parker; Green Mountain Conservation Group and Saco River Corridor Commission, 2003.
2. Ossipee Watershed Water Quality Monitoring Program 2002 Pilot Season Summary Report, Green Mountain Conservation Group, 2003.
3. New Hampshire Volunteer Lake Assessment Field Manual, Version 1.0, New Hampshire Department of Environmental Services, 2001.
4. Ossipee Lake Protection Program, Ossipee Lake Alliance, 2003.
5. Society for the Protection of the New Hampshire Forests, through a grant from the US Forest Service, to produce a series of Natural Resource Inventory (NRI) maps.
6. Saco River Basin Water Quality Monitoring Program (SRBP), 2002.
7. University of New Hampshire Standard Operating Procedures (SOPs), University of New Hampshire Cooperative Extension Agency, Durham, New Hampshire.
8. NHDES Limnology Center Laboratory Manual, 2003 Edition. New Hampshire Department of Environmental Services, 2003.

APPENDIX A: Field-sampling SOPs

1. Step by Step Monitoring Procedures Including Calibration

These methods follow the instructions given in the NHVLAP Monitors Field Manual. Due to differing laboratory techniques, Total Phosphorus samples for UNH do not require Sulfuric Acid as a preservative in the field.

Tributary Sampling

Note – volunteers should turn the pH and dissolved oxygen meters on approximately a half hour before they calibrate or take a reading. Both YSI meters need to warm up before being used. If you know that other volunteers are going to use the meters after you, please leave the meters on to avoid further waiting periods. Each meter has approximately 100 hours of battery life so they will not go dead when kept on for several hours at a time.

Temperature

Both the pH and the Dissolved Oxygen meters come with built in thermometers. Each volunteer will also have a pocket thermometer to place in the water to check against the temperatures given by the meters. It is suggested that the first step when arriving at a site is to place the pocket thermometer in the water so it has ample time to arrive at an accurate reading. Equally important is to remember to take it with you when you leave.

With three sources of temperature it should be fairly easy to determine. However, it is the temperature readings given by the pH meter, and the pocket thermometer, that will be recorded on the field data sheet.

Collecting Water Samples

Volunteers should collect two water samples using the 250 ml plastic bottles provided in the equipment kits. However, for quality control purposes 2 additional replicate samples will need to be collected each monitoring week at one test location. All four bottles should be labeled, 2 as normal and 2 as replicate. Volunteers will be notified when it is their turn to collect replicate samples in addition to the standard two samples.

The rim of the bottle should not be touched with your hands after the cap is taken off. Place the first bottle into the stream/river so that the water flows into the bottle. It is important not to stir up particulates before collecting these samples as contamination may affect the analysis readings. Cap the bottle before bring the bottle to the surface. Follow the same procedures for the second water sample.
GMCG and SRCC volunteers must label each sample (with the permanent marker provided) with the Site Code Number, Time and Date Collected, and the collector's

initials. Also, be sure to note the time the samples were collected for each on to the field data sheet.

Turbidity

Calibrating the 2100P Portable Turbidimeter

This meter goes through two series of calibration. The primary calibration is done based on formazin, the standard for turbidity. This process involves the use of four Stabilized Formazin Standards, and should be completed at least once every three months. The instrument's design provides for long-term stability and minimizes the need for frequent primary calibration. However, the meter should be calibrated using Gelex secondary turbidity standards once a month. The meter comes with vials of Gelex that must be assigned a NTU value with the meter. These determined values should be rechecked at least once a month to assure that the meter's accuracy stays within 5% of the original value given.

Both primary and secondary calibrations will be done by water quality staff. Primary calibration will be completed at the beginning of each testing season, again in late June/early July, and finally at the end of the testing season. The secondary calibration procedures will be done every month, or every other testing cycle.

Measuring Turbidity using the2100P Portable Turbidimeter

Important: The turbidimeter must be on a flat, stable surface to accurately take a reading. It may be easiest to leave the meter in its case for these testing procedures. Do not hold the meter while taking a reading!

STEP 1
Collect water sample in clean, glass sample cell. Be sure to fill sample to the top and cap the cell underwater to avoid air bubbles.

STEP 2
While holding the cell from the black cap, dry the cell with a paper towel. Once dry, apply three dots of silicone oil down the side of the cell. Using the velvet side of the black cloth, evenly distribute the oil around the cell (do not rub excessively). Try to apply a coat that is even. You shouldn't be able to see the silicone oil once it has been applied to the sample vial. Also avoid getting fingerprints on the glass.

STEP 3
Turn the meter on by pressing the Power I/O key located at the bottom right of the key pad.

STEP 4

Insert the sample cell making sure that the bottom point of the triangle on the vial lines up with the raised notch in front of the cell hole. Close the lid.

STEP 5
Look in the display to be sure that you see AUTO RNG and SIG AVG. If you do not see AUTO RNG press the range key located at the bottom left of the keypad until you do. If you do not see SIG AVG press the Signal Average key located at the top right of the key pad.

STEP 6
Press the Read key located in the bottom middle of the key pad. The zeros in the display will turn to lines and NTU will be blinking on the right. Towards the bottom left of the display there will be a light bulb. It should be a steady light bulb opposed to blinking. When the light bulb disappears, record your reading.

STEP 7
Remove the sample cell from the meter. Dump the water from the cell.

STEP 8
Collect another water sample. Properly dry the sample with a paper towel and apply the silicone oil as you did before, and proceed to Steps 4 through 7 to obtain your second Turbidity readings to be logged onto your field data sheet.

STEP 9
Turn the meter off. Always be sure to remove the sample cell from the meter before putting it away.

pH

Calibrating the YSI 60 Portable pH Meter
GMCG Volunteers

Please remember to turn the YSI 60 meter on at least a half an hour before calibration to warm up. If you know there are other volunteers who are going to use the meter after you, please leave the meter on after you are done with it.

The YSI 60 Portable pH meters **must** be calibrated before making pH measurements. On the first day of the monitoring week (Monday), volunteers should perform a 3 point calibration of the pH meters, prior to use. On the remaining volunteer days (Tuesday-Friday) volunteers will perform a two point calibration of the pH meters. ***Only the first volunteer of the day that uses the pH meter needs to perform a calibration.***

STEP 1

Turn the instrument on by pressing the **ON/OFF** key if it wasn't already on and allow the meter to warm up for at least 30 minutes.

STEP 2
Remove the probe from it's storage chamber and rinse the probe with distilled or deionized water.

STEP 3
Place the 30 mL of pH 7.00 (yellow) buffer in the 100 mL graduated cylinder.

STEP 4
Immerse the probe making sure that both the pH and temperature sensors are covered by the solution.

STEP 5
Using two fingers press and release the **UP ARROW** and the **DOWN ARROW** keys on the pH meter at the same time. The meter display will show **CAL** at the bottom, **STAND** will be flashing in the lower left hand corner and the main display will show 7.00.

STEP 6
Press the **ENTER** key. The meter display will show **CAL** at the bottom; **STAND** will stop flashing; and the offset pH value will be shown with the middle decimal point flashing. Don't worry about the value, the meter automatically corrects the pH measurement according to temperature difference.

STEP 7
When the reading becomes stable the decimal point will stop flashing. Press and hold the **ENTER** key to save the calibration point. The meter display will flash **SAVE** along with **OFS** to indicate that the offset value has been saved.

STEP 8
SLOPE will now appear on the display and will be flashing. The main display may show either a measurement of approximately 4.01 **or** 10.02 (+ or – a few hundredths of a unit). This indicates that the slope is now ready to be set using a second pH buffer.

STEP 9
Remove the probe from the graduated cylinder and rinse with distilled or deionized water.

STEP 10
Empty the 7.00 pH buffer from the graduated cylinder into the container it came in and rinse the cylinder with distilled or deionized water.
STEP 11
Place the 30 mL of pH 4.01 (red) buffer into the graduated cylinder.

STEP 12

Immerse the probe making sure that both the pH and temperature sensors are covered by the solution. The main display should now show a measurement of 4.01.

STEP 13
Press the **ENTER** key. The meter display should now show **CAL** at the bottom; **SLOPE** will stop flashing and the offset pH value will be shown with the decimal point to the left of the 4 flashing. Don't worry about the value, the meter automatically corrects the pH measurement according to temperature difference.

STEP 14
When the reading becomes stable the decimal point will stop flashing. Press and hold the **ENTER** key to save the calibration point. The meter display will flash **SAVE** along with **OFS** and **SLP** to indicate that the offset value has been saved.

STOP HERE IF YOU ARE PERFORMING A TWO POINT CALIBRATION. PRESS THE MODE KEY TO RETURN TO NORMAL OPERATION. IF YOU ARE PERFORMING A THREE POINT CALIBRATION PLEASE CONTINUE WITH THE REMAINING STEPS.

STEP 15
SLOPE will now appear on the display and will be flashing. The main display may show either a measurement of approximately 4.01 **or** 10.02 (+ or – a few hundredths of a unit). This indicates that the slope is now ready to be set using a third pH buffer.

STEP 16
Remove the probe from the graduated cylinder and rinse with distilled or deionized water.

STEP 17
Empty the 4.01 pH buffer from the graduated cylinder into the container it came in and rinse the cylinder with distilled or deionized water.

STEP 18
Place the 30 mL of pH 10.01 (blue) buffer into the graduated cylinder.

STEP 19
Immerse the probe making sure that both the pH and temperature sensors are covered by the solution. The main display should now show a measurement of 10.01(+ or – a few hundredths of a unit).

STEP 20
Press the **ENTER** key. The meter display should now show **CAL** at the bottom; **SLOPE** will stop flashing and the offset pH value will be shown with the decimal point to the right of the second zero flashing. Don't worry about the value, the meter automatically corrects the pH measurement according to temperature difference.

STEP 21
When the reading becomes stable the decimal point will stop flashing. Press and hold the **ENTER** key to save the calibration point. The meter display will flash **SAVE** along

with **OFS** and **SLP** to indicate that the offset value has been saved. Press the MODE key to return to normal operation.

STEP 22
Empty the 10.01 pH buffer from the graduated cylinder into the container that it came in and rinse the cylinder with distilled or deionized water.

Measuring pH using the YSI 60 Portable pH Meter

Please remember to turn the YSI 60 meter on at least a half an hour before taking a reading, if it was not already on when you received the meter. The YSI meters need time to warm up before being used. If you know there are other volunteers who are going to use the meter after you, please leave the meter on after you are done with it.

Follow these instructions after the meter has been successfully calibrated. **The pH probe does not need to be stirred while in the water.**

STEP1
If the meter was not already on, press the **ON/OFF** button in the left hand corner of the meter to turn it on. Allow the meter to warm up for at least 30 minutes before using it. If you are not the first person using the meter on this day, then the meter should already be on when you receive it. If it was not, please make a note of this on the data sheet or bring this to the attention of the Water Quality Program Director.

STEP 2
Place the probe in the water. Make sure that both the pH and temperature sensor are completely immersed in the water.

STEP 3
The probe does not need to be stirred in the water. The reading may take a few minutes to stabilize. When the number to the nearest tenth of a unit (i.e 7.32 – the 3 is the nearest tenth) stops fluctuating, the reading has stabilized. Record this measurement on the data sheet as well as the temperature indicated on the meter.

STEP 4
Remove the probe from the water and then place the probe back in the water.

STEP 5
Repeat step 3.

STEP 6
When you have recorded the second pH and temperature readings, place the meter back in its case as you found it. Please make sure that the probe tip is not left in the open as the glass bulb will dry out. If you are the last person to use the meter that day you may shut the meter off. If you know that there are other volunteers who are going to use the meter after you, please leave the meter on.

Dissolved Oxygen

Calibrating the YSI 550A Portable Dissolved Oxygen Meter
GMCG Volunteers

Please remember to turn the YSI 550A meter on at least a half an hour before calibration to warm up. If you know there are other volunteers who are going to use the meter after you, please leave the meter on after you are done with it.

The YSI 550A Portable Dissolved Oxygen meters **must** be calibrated before making measurements. ***Only the first volunteer of the day that uses the Dissolved Oxygen meter needs to perform a calibration***. There are several ways to calibrate the YSI 550A Dissolved Oxygen Meter. We are going to use the Calibration in % Saturation method.

STEP 1
Make sure that the probe is inserted into the calibration/storage chamber and the sponge inside is moist.

STEP 2
Turn the meter on by pressing the green power key located in the left hand corner of the meter. Allow the reading to stabilize. This may take a few minutes. When the number to the nearest tenth of a unit (i.e. 9.3 – the 3 is the nearest tenth) stops fluctuating, the reading has stabilized.

STEP 3
Press and release both the **UP** and **DOWN ARROW** keys at the same time to enter into the calibration menu.

STEP 4
The screen will display **CAL** and **%.** Press the ENTER key (an arrow pointing left, in the right hand corner of the meter).

STEP 5
The screen will prompt you to enter the local altitude in hundreds of feet and will say 0.0. If the screen does not already display the number 5, use the **UP ARROW** key to enter the number 5 for 500 feet. (The meter will only let you enter the first # of the altitude). Then press the **ENTER** key (an arrow pointing left, in the right hand corner of the meter).

STEP 6
Wait for the DO reading on the main display to stabilize. Again, when the number to the nearest tenth of a unit (i.e. 89.3 – the 3 is the nearest tenth) stops fluctuating, the reading has stabilized. Once the reading has stabilized, press the **ENTER** key (an arrow pointing left, in the right hand corner of the meter).

STEP 7
The screen will prompt you to enter the percent salinity and will say 0.0. Since we are dealing with freshwater, which has no salinity, press the **ENTER** key (an arrow pointing left, in the right hand corner of the meter). The meter will automatically return to normal operation and is ready for use.

Measuring Dissolved Oxygen using the YSI 550A Portable Dissolved Oxygen Meter

Please remember to turn the YSI 550A meter on at least a half an hour before taking a reading, if it was not already on when you received the meter. The YSI meters need time to warm up before being used. If you know there are other volunteers who are going to use the meter after you, please leave the meter on after you are done with it.

The tip of the electrode (the membrane) is submerged in a special filling solution that will leak out around the threads if they are accidentally loosened. Please be very careful not to unscrew or damage the tip of the electrode. The membrane should never come into contact with hard, scratchy surfaces such as rocks, sand and pebbles. If you suspect that the tip is damaged (the meter will not work properly) please make a note on the data sheet.

Follow these instructions after the meter has been successfully calibrated. **The dissolved oxygen probe DOES need to be continuously stirred while attempting to take a reading.**

STEP 1
If the meter was not already on, press the **ON/OFF** button in the left hand corner of the meter to turn it on. Allow the meter to warm up for at least 30 minutes before using it. If you are not the first person using the meter on this day, then the meter should have been on when you received it. If it was not on, please make a note of this on the data sheet or bring this to the attention of the Water Quality Program Director.

STEP 2
If you have not already done so, remove the probe from the storage chamber.

STEP 3
Place the probe in the water, making sure that both the DO and temperature sensors are completely immersed in the water.

STEP 4
Press the **MODE** key located in the left hand corner of the meter to change the measurement units to mg/L. There are three modes - %, mg/L and then a third that measures salinity. You should only have to press the MODE key once to get it into mg/L, but if you go by it, keep pressing the MODE key again until you return to mg/L.

STEP 5
When the number to the nearest tenth of a unit (i.e. 9.32 – the 3 is the nearest tenth) stops fluctuating, the reading has stabilized. Record this measurement on the data sheet. Do not remove the probe yet!

STEP 6
Press the **MODE** key twice to change the measurement unit to %. Record this measurement onto the data sheet.

STEP 7
Remove the probe from the water and then place the probe back in the water.

STEP 8
Repeat step 3 through 6.

STEP 9
When you have recorded the second dissolved oxygen readings, place the probe back in the storage chamber. If you are the last person to use the meter that day you may shut the meter off. If you know that there are other volunteers who are going to use the meter after you, please leave the meter on.

Deep Spot Sampling

Collecting Water Samples

The camp volunteers and the OLA staff coordinator will travel to the deep water spot on each lake using the camp boat, which will have enough life vests for everyone on the boat
Under the supervision of the staff coordinators the volunteers will locate the deep spot through triangulation, which involves using three reference points on the shoreline or with fish finders and GPS devices, if available.

The volunteers will set up the Kemmerer Bottle and fill it with water to "sound" the bottom to ensure the deepest spot has been located. Since sounding may disturb the sediment, the volunteers then allow the bottom to settle before collecting the water sample from the deepest spot, the depth of which is noted on the field data sheet.

The volunteers will subsequently lower the open Kemmerer Bottle and Sender to the desired depth, which has been predetermined by a DES biologist. Next, they will drop the Messenger down the chain to close the bottle and collect the samples, checking to ensure that there is no sediment in the Kemmerer Bottle. If any sediment is observed, the process will be repeated from a different location in the boat.

At each depth, the volunteers will rinse a large white bottle with a small amount of water from the Kemmerer Bottle, shake, and discard it. Then they fill the sample bottle to the neck with the collected water. The volunteers will also fill a small brown phosphorus bottle at each depth, being careful not to rinse or overflow the small brown bottle since it contains sulfuric acid preservative which cab burn hands and clothing.

Determining Transparency

The volunteers will securely attach the Secchi Disk to the calibrated chain with the clip and lower the disk into the water on the shady side of the boat until it disappears, ensuring that the reading is not affected by reflections or wave action. The disk is then pulled up slowly until the volunteers can just barely see the white portion. The chain is then grabbed at the water surface to determine the depth from the markers. The depth is estimated to tenths of a meter. Each volunteer on the boat repeats this task and the readings are recorded. The average of the readings is used as the official reading.

Chlorophyll-A

Method 1: Composite

1.) The volunteers rinse out the bucket with lake water.

2.) The Kemmerer Bottle will then be lowered to the designated depth, as explained previously, and the water sample will be collected. Half of the water is then be deposited into the bucket.

3.) The volunteers continue to deposit about half the water from the Kemmerer Bottle from each meter until they reach the surface. (For example, for a 4-meter composite sample the volunteers will need an equal amount of water from the Kemmerer Bottle from depths of 4, 3, 2 and 1 meter.

4.) The volunteers then rinse the large brown bottle with the water from the bucket and fill the bottle with the composite water sample.

Volunteers will then run through the Field Data sheet and if everything has been filled in they will leave the deep spot and go to another location or start the next task.

Method 2: Integrated Tube

1.) The volunteers will rinse out the bucket with lake water.

2.) The volunteers will connect the calibrated chain to the weighted end of the Integrated Tube and will lower both the weighted end and chain to the same depth, avoiding slack in the tube and chain.

3.) The volunteers will crimp the end of the tube tightly and haul the weighted end up by the chain, not the tube itself. The weighted end will then be placed in the bucket and the tube is un-crimped.

4.) A volunteer then lifts the un-crimped end above his head so that the open end is higher than the water level in the tube, allowing the water to drain quickly.

5.) Finally, the volunteers will rinse out the large brown bottle (the one that does not contain acid) and fill the bottle with the samples.

Volunteers will then run through the Field Data sheet and if everything has been filled in they will leave the deep spot and go to another location or start the next task.

Returning To the Lab

All water samples will be returned to the NHDES Limnology Center within 24 hours of collection, the maximum holding period, for analysis. Staff coordinators will keep the samples in a cooler on ice until they can be delivered to Concord. The coordinators will make a copy of the Field Data sheet for the project's records before dropping it off in Concord with the samples. They data sheet will inform the Limnology Center or any unusual circumstances encountered in the field, such as extreme weather, near-by shoreline construction projects, algae blooms, water discoloration and the like.

APPENDIX B: UNH QA Manual and SOPs

2. Water Quality Analysis Laboratory, Water Resource Research Center, University of New Hampshire

Bill McDowell, Director
Jeff Merriam, Lab Manager
Department of Natural Resources
215 James Hall, Durham, NH 03824
(603) 862-2341

Summary Of Analysis Techniques And Methods:
Complete SOP's are referenced in Appendix E.

Anions (Chloride, Nitrate, Sulfate = Cl, NO_3^-, SO_4^{-2})
Analyzed using an Ion Chromatograph with suppressed conductivity detection. EPA method #300.1

Cations (Sodium, Potassium, Magnesium, Calcium = Na^+, K^+, Mg^{+2}, Ca^{+2})
Analyzed using an Ion Chromatograph with conductivity detection. Not an EPA approved method.

Dissolved Organic Carbon (DOC)
Analyzed using a Shimadzu TOC-V carbon analyzer. The technique is referred to as High Temperature Catalytic Oxidation (HTCO), or sometimes High Temperature Oxidation (HTO) (there's some debate whether the catalyst really does anything). I typically say HTCO. Basically the water sample is injected into a hot furnace containing catalyst. Any carbon in the sample, not including inorganic carbon (bicarbonate, carbonate, and carbon dioxide, which has been removed from the sample by acidification and sparging in the lab) is burned and converted to CO_2, which is then measured.
EPA method #415.1

Total Dissolved Nitrogen (TDN)
HTCO with chemiluminescent N detection. Analyzed using a Shimadzu TOC-V carbon analyzer with a chemiluminescent Nitrogen detector. All N in the sample is burned and converted to NO_2, which is measured via a chemiluminescent detector.
Not an EPA approved method, but it's widely accepted. Often the EPA is very slow to "approve" new methods, and therefore behind the technological curve.
A reference for the method if you need it is J.L. Merriam, W.H. McDowell, and W.S. Currie. 1996. A High-temperature oxidation technique for determining total dissolved nitrogen. Soil Science Society of America Journal 60:1050-1055.

Ammonium (NH_4^+)
Automated Phenate Method. A colorimetric determination using automated flow injection analysis (FIA) on a Lachat Instruments QuikChem AE.
EPA method 350.1

Soluble reactive phosphate (aka SRP, or orthophosphate, PO_4^{-2})

Automated Ascorbic acid method. A colorimetric determination using automated flow injection analysis (FIA) on a Lachat Instruments QuikChem AE.
EPA method 365

Silica (SiO_2)

Automated Molybdate Reactive Method. A colorimetric determination using automated flow injection analysis (FIA) on a Lachat Instruments QuikChem AE. *Standard Methods for the Examination of Water and Wastewater*, 18th Edition, 1992, American Public Health Association, 1015 Fifteenth Street NW, Washington, D.C. 20005.

3. UNH Total Phosphorus SOP (2002)

The total phosphorus method is based on Standard Methods for the Examination of Water and Wastewater (20th edition); 4500-P E. Ascorbic Acid Method.

Note: use extreme caution when handling the phosphorus analytical glassware. If there is any doubt of the cleanliness of the glassware, acid wash all applicable materials as described in step three before preceding any further.

Remove a maximum of 34 total phosphorus samples from the freezer and let them thaw.

In the morning, make up the following reagents as described in the section "Mixing other reagents":

Phosphorus Standard Solutions (1 Liter volumetric flasks)
dd H_2O blank (1 Liter volumetric flask)
5 N H_2SO_4
11N H_2SO_4
10N NaOH

3) Acid wash (Place in the 30% HCl acid bath for 10 minutes):

84	125 ml Erlenmyer flasks
1	50 ml graduated cylinder TD
1	100 ml graduated cylinder TD
1	250 ml graduated cylinder TD
1	plastic 0.5 g measuring scoop (for ammonium peroxydisulfate)
1	1000 ml volumetric flask
1	400 ml beaker
1	10 ml glass pipette

4) Transfer all pertinant information from the total phosphorus sample bottle to the total phosphorus data sheet at this time (i.e. lake, site, date, depth, etc.).

5) Prepare sample flasks as follows:

Arrange the 125 ml Erlenmyer flasks (Corning # 5100-125) alpha-numerically, 1A through 42B, and place the flasks sequentially into the polypropylene sterilizing trays before filling the flasks with samples. Invert each sample twice and rinse the 50 ml graduated cylinder with the sample. Measure 50 mls of sample and pour into the replicate Erlenmyer Flasks (A & B). Make sure you mix the water sample before pouring out each replicate stream sample (you often have inorganic particulate debris that rapidly settle out). Between replicate samples (i.e. 1B and 2A) rinse out the graduated cylinder with 30% HCl and then with double distilled water (dd H_2O).

Pour out the blank as follows:

Shake the 1000 ml volumetric flask containing the dd H_2O blank well. Rinse the 50 ml graduated cylinder three times with dd H_2O and then with the (acidified) dd H_2O blank. Measure 50 mls of sample and place into the replicate Erlenmeyer flasks (50 mls into each flask).

Pour out the Standards as follows:

Invert the 1000 ml volumetric flask containing the phosphorus standard twice. Rinse the 50 ml graduated cylinder with phosphorus standard and than measure 50 mls of sample and place into the replicate Erlenmeyer flasks (50 mls into each flask). *Note: if you are running a standard curve, serial dilute your phosphorus standard using* ***acidified*** *dd H_2O. Your standard curve should include standards ranging from 1.3 to 333.33 ppb.*

6) Add 1 ml of 11N H_2SO_4 to each Erlenmeyer flask with the Labsystems adjustable pipetter (FS cat # 21-377-109) and then add 1 level scoop (0.5 g plastic scoop HACH cat # 492-00) of ammonium peroxydisulfate into each flask (note: make sure the pippetter is set to dispense 1 milliliter of acid). Cap each flask with a #6 glass stopper (FS Cat # 10-042A) and swirl each flask to assure the reagents are well mixed.

7) Place flasks into the Gettinge Novus I autoclave, adjust the setting to liquids, make sure the temperature is set to 123° C and set the timer to 30 minutes as indicated below.

a) Select "Sterilize Temperature" under the Cycle Values setting and set it to 123.0°C by pressing either the "up arrow" or the "down arrow".
b) Select "Sterilize Time" under the Cycle Values setting and set it to 30 minutes by pressing either the "up arrow" or the "down arrow".
c) Select "Liquids" under the Cycle Select setting. **(It is imperative the autoclave switch is set to liquids, otherwise your samples will vaporize as the autoclave heats up and the samples will be lost).**
d) Once you are sure the settings have been properly adjusted press the "start" button. Stay in the room until the autoclave heats up to 123.0°C to assure the samples are digesting.

8) After 1 to 1.5 hours remove the TP samples from the autoclave using the red thermally insulated gloves.

9) Turn on the Milton Roy Spectronic 1001^+ at this time. The Milton Roy Spectronic 1001^+ should be on at least 30 minutes prior to running samples to assure stable readings.

10) As the samples near room temperature mix the following reagents:

Ammonium Molybdate	4.0 grams per 100 milliliters dd H_2O
Ascorbic Acid	1.76 grams per 100 milliliters dd H_2O
Potassium Antimonyl tartrate	0.28 grams per 100 milliliters dd H_2O

11) Once the phosphorus samples cool to room temperature (25°C) remove the caps and add one-drop phenalthelien indicator to each flask. Neutralize each sample to a faint pink color by dispensing 1.4 ml 10N NaOH from the Labsystems pipetter into each flask. *Note: make sure the volume is set to 1.4 ml before beginning*. Following the addition of NaOH to all samples, swirl each flask individually; the pink color should disappear at this point. If the pink color persists, however, consult the laboratory manager.

12) Mix the combined reagent:

The combined reagent should be mixed in a 1000 ml (acid washed) Volumetric flask by measuring the volume of reagents in a graduated cylinder and adding the reagents in the following order (note: the reagents must be added in this order for the proper molecule to form and the graduated cylinder should be rinsed with dd H_2O between the addition of each reagent); mixing the volumetric flask as each reagent is added:

1) 500 mls 5N H_2SO_4
2) 50 mls Antimony Potassium Tartrate
3) 150 mls Ammonium Molybdate
4) 300 mls Ascorbic Acid

Note: the mixed reagent is very unstable and should be made immediately prior to adding to the sample flasks.

13) Add the mixed reagent using the yellow and black pipetter (FS Cat# 13-681-25), rinsing the pipette by pippetting a sample of mixed reagent from the beaker and discarding it. After rinsing the pipette tip, add 8 mls of mixed reagent to each successive flask. As the mixed reagent is added a molecular complex (molybdenum blue) will form in the sample. The concentration of the molybdenum blue complex is proportional to the phosphorus concentration in the sample. While differences in color (low phosphorus concentrations) are not visible to the unaided eye, high phosphorus concentrations become various shades of blue; the bluer the sample the greater the phosphorus concentration.

14) Begin sample analysis 30 minutes after adding the mixed reagent to the first sample. Record the absorbances at 660 and 880nm on the total phosphorus data sheet. The spectrophotometer should be blanked with dd H_2O and blanks should also be run after every 10 flasks and should always be run after the final phosphorus sample has been run. Record the blank absorbances (660 and 880nm) and the dd H_2O blank results on the datasheets.

15) All phosphorus samples should be poured into a white (one gallon) paint bucket and neutralized with baking soda prior to disposal.

16) Glassware cleanup - Immediately rinse out the flasks and other glassware three times with dd H_2O after the run and place the glassware in the drying rack on the Rubbermaid cart. If there is room, place the rinsed glassware into the acid bath and let sit for one hour, otherwise, fill the flasks with dd H_2O and place out of the way until room becomes available in the acid bath. When pulling glassware out of the acid bath rinse three times with dd H_2O and place the glassware upside-down in the drying rack.

Written By Bob Craycraft
Center for Freshwater Biology Laboratory
Last Updated on March 22, 2002
C:/llmp lab directions and datasheets/Total Phosphorus Procedure 2002.doc

4. QAPP for the Water Quality Analysis Lab at the University of New Hampshire, Department of Natural Resources, Durham, NH.

I. Laboratory Organization and Responsibility

Dr. William H. McDowell - Director

Jeffrey Merriam – Lab Manager/QA manager. Mr. Merriam supervises all activities in the lab. His responsibilities include data processing and review (QA review), database management, protocol development and upkeep, training of new users, instrument maintenance and repair, and sample analysis.

Jody Potter – Lab Technician. Mr. Potter's responsibilities include sample analysis, logging of incoming samples, sample preparation (filtering when appropriate), daily instrument inspection and minor maintenance.

All analyses are completed by Jody Potter or Jeffrey Merriam, and all data from each sample analysis batch (generally 40-55 samples) is reviewed by Jeffrey Merriam for QC compliance. All users are trained by the lab manager and must demonstrate (through close supervision and inspection) proficiency with the analytical instrumentation used and required laboratory procedures.

II. Standard Operating Procedures

Standard Operating Procedures for all instruments and methods are kept in a 3-ring binder in the laboratory, and are stored electronically on the Lab manager's computer. The electronic versions are password protected. SOPs are reviewed annually, or as changes are required due to new instrumentation or method development.

III. Field Sampling Protocols

Sample collection procedures are generally left up to the sample originators, however we recommend the guidelines described below, and provide our field filtering protocol on request.

All samples are filtered in the field through 0.7 um precombusted (5+ hours at 450 C) glass fiber filters (e.g. Whatman GF/F). Samples are collected in acid-washed 60-mL HDPE bottles. We prefer plastic to glass as our preservative technique is to freeze. Sample containers are rinsed 3 times with filtered sample, and the bottle is filled with filtered sample. Samples are stored in the dark and as cool as possible until they can be frozen. Samples must be frozen within 8 hours of sample collection. Once frozen, samples can be stored indefinitely (Avanzino and Kennedy, 1993), although they are typically analyzed within a few months.

After collection and freezing, samples are either hand delivered to the lab, or are shipped via an over-night carrier. Samples arriving in the lab are inspected for frozen contents, broken caps, cracked bottles, illegible labels, etc. Any pertinent information is entered into a password-protected database (MS Access).

We do not require chain of custody paperwork unless a specific project requires it. If a project requires chain of custody, forms are provided by the specific project's manager.

IV. Laboratory Sample Handling Procedures

Samples are given a unique 5-digit code. This code and sample information including name, collection date, time (if applicable), project name, collector, logger, the date received at the WQAL, sample type (e.g. groundwater, surface water, soil solution) and any other miscellaneous information, are entered into a password protected database. From this point through the completion of all analyses, we use the log number to track samples. Log numbers are used on sample run queues, spreadsheets, and when importing concentrations and run information into the database

After samples are logged into the WQAL, they are stored frozen in dedicated sample freezers located in the laboratory. Samples from different projects are kept separated in cardboard box tops, or in plastic bags. Samples that may pose a contamination threat (based on the source or presumed concentration range) are further isolated by multiple plastic bags, or isolation in separate freezer space. This is typically not an issue as we primarily deal with uncontaminated samples.

We do not pay special attention to holding time of samples, as frozen samples are stable indefinitely (Avanzino and Kennedy, 1993). However, we do keep track of the date samples arrive at the WQAL, and can report holding times if necessary. After samples are analyzed they are returned to the project's manager for safekeeping or they are held for a period of time at the WQAL to allow necessary review and analysis of the data by the interested parties (not from a laboratory QC sense, but from a project specific viewpoint). Once the data is analyzed by the project's manager(s), the samples are returned or disposed of, based on the preference of the project's manager.

Chain of custody is only implemented when required by a specific project. This is usually only when it's required by the funding agency, or if the samples could be the basis for an enforcement action.

Samples that arrive unfrozen, with cracked bottles/caps, or with loose caps, are noted in the database and are not analyzed. These samples are disposed of to prevent accidental analysis. The sample originator is notified (generally via e-mail) of which samples were removed from the sample analysis stream. Similarly, if while in the possession of the WQAL, a sample bottle is broken or improperly stored (e.g. not frozen), the sample is removed and the sample originator is notified.

V. Calibration procedures for chemistry

Calibration curves are generally linear, and are made up of 4-7 points. A full calibration is performed at the beginning of each run (a run is generally 40-60 samples) with a reduced calibration (3-5 points) performed at the end of the run. Occasionally calibration data is best fit with a quadratic equation, and this is used if it best describes the data within a specific run.

Standards are made from reagent grade chemicals (typically JT Baker) that have been dried and are stored in a desiccator. Working stock solutions are labeled with the content description, concentration, initials of the maker, and the date the stock solution was made. Generally stock solutions are kept less than one week; however some stocks (Br, Na, Cl, C for DOC) can be stored for several months. Standard solutions are kept for less than one week from the date they were made. Stocks and standards are stored tightly covered, in a dark refrigerator.

Control charts are prepared and printed every few months. However data from each run are looked at within days of analyses. Calibration curves, Laboratory Duplicates, Lab Fortified Blanks (LFB), Lab Fortified Sample Matrices (LFM) and Lab Reagent Blanks (LRB) are reviewed and are checked against known concentrations (where applicable) to ensure QC criteria are met for each run of samples.

VI. Data Reduction, validation, reporting and verification

Data reduction and validation are performed in a spreadsheet (MS Excel). The Raw data page of the spreadsheet lists the date of analysis, user, analysis performed, project, any issues or problems noted with the instrument on that date, and the sample queue and the raw data exported from the instruments. Most raw data is exported as an area or an absorbance value. A second page (typically named “Calculations”) is added to the spreadsheet where known concentrations of standards, check standards and reference solutions are added. The calibration curve(s) is calculated and the concentrations are calculated on this page. Calculated concentrations for all standards, LFB, LFM and IPC are compared to the “known” or prepared values. If these are

acceptably close (+/- 10% of the "known") no further changes to the calculated concentrations are made. If there is evidence of drift in the response of the instrument during a run, we try to correct for the drift using the responses from the front-end calibration curve and the set of standards analyzed at the end of the run. All reference solutions and replicates must meet certain QC criteria (described below) for a run to be accepted.

Data are then exported to the WQAL database. Exported information includes the unique 5-digit code, calculated concentration, the analysis date, the user, the filename the raw data and calculations are saved in, and any notes from the run regarding the specific sample. Data are sent to sample originators upon completion of all requested sample analyses and following review by the WQAL lab manager. Generally the data include the 5-digit code, the sample name, collection date, and concentrations, in row-column format. Any information entered into the database can be included upon request. Data transfer is typically via e-mail or electronic medium (CD or floppy disk).

All data corrections are handled by the lab manager. Corrections to data already entered into the database are very infrequent. Typically they involve reanalysis of a sample. In this case, the old data is deleted from the database, and the new value is imported, along with a note indicating that it was re-analyzed, the dates of initial and secondary analysis and the reason for the correction.

Hand written or computer printed run sheets are saved for each run and filed, based on the project and the analysis. Spreadsheet files with raw data and calculations are stored electronically by analysis and date. Information in the database allows easy cross-reference and access from individual samples to the raw data and the runsheets. This provides a complete data trail from sample login to completion of analysis.

VII. Quality Control

All analyses conducted at the WQAL follow approved or widely accepted methods (Table 1).

Quality Control Samples (QCS) (from Ultra Scientific) are analyzed periodically (approximately every 20 samples) in each sample analysis batch to assure accuracy. The response/unit concentration is also used to monitor day-to-day variation in instrument performance. A difference from the certified concentration of more than 10% requires further investigation of that run. A difference greater than 15% is failure (unless the average of the two samples is less than 10X the MDL), and results in re-analysis of the entire sample queue, unless there is a very reasonable and supported explanation for the inconsistency. Table 2 lists historical average % recoveries. At least 2 QCS are analyzed on each run.

Standards and reagents are prepared from reagent grade chemicals (typically JT Baker) or from pre-made stock solutions. All glassware is acid washed (10% HCl) and rinsed 6 times with ultra pure-low DOC water (18.2 mega-ohm). All analyses (except CHN) use multi-point calibration curves (4-7) points, which are analyzed at the beginning and the end of each run. A Laboratory Reagent Blank (LRB), Laboratory Fortified Blank (LFB) (a standard run as a sample) and Laboratory Duplicate are analyzed every 10 to 15 samples during each run. At least one Laboratory Fortified Sample Matrix (LFM) is analyzed during each run to insure that sample matrices do not affect method analysis efficiency. Field Duplicates are not required by our lab, and are the responsibility of the specific project's manager.

Laboratory Duplicates must fall within 15% relative percent difference (RPD = abs (dup1-dup2)/average of dup1 and dup 2). A difference greater than 10% requires further investigation of the sample run. A difference greater than 15% is failure (unless the average of the two samples is less than 10X the MDL), and results in re-analysis of the entire sample queue, unless there is a very reasonable and supported explanation for the inconsistency. Long-term averages for relative % difference are included in Table 2.

LFM must show 85% to 115% recovery. A recovery <90% or > 110% requires further investigation of the sample run. A recovery <85% or >115% is failure (unless the sample is less than 10X the MDL), and results in re-analysis of the entire sample queue, unless there is a very reasonable and supported explanation for the inconsistency. Long-term averages for % recovery are included in Table 2.

Method Detection Limits are calculated at least twice per year, or whenever major changes to instrumentation or methods occur. Table 2 lists most recently measured MDL values.

VIII. Schedule of Internal Audits

Internal audits are not routinely performed, however, review of QC charts, and tables are done at least quarterly by the lab manager.

IX. Preventive maintenance procedures and schedules

The laboratory manager, Jeff Merriam, has 10 years of experience and is highly experienced with all laboratory equipment used within the WQAL. The laboratory manager conducts all maintenance and inspection of equipment based on manufacturer requirements and specifications.

Each day an instrument is used, it receives a general inspection for obvious problems (e.g. worn tubing, syringe plunger tips, leaks). The instruments are used frequently and data is inspected within a few days of sample analysis. This allows instrument (or user) malfunctions to be caught quickly, and corrected as needed.

Each day's run is recorded in the instrument's run log, with the date, the user, the number of injections (standards, samples, and QC samples), the project, and other notes of interests. Maintenance, routine or otherwise, is recorded in the instrument run log, and

includes the date, the person doing the maintenance, what was fixed, and any other notes of interest.

X. Corrective Action Contingencies

Jeffrey Merriam is responsible for all QC checks and performs or supervises all maintenance and troubleshooting. When unacceptable results are obtained (based on within sample analysis batch QC checks) the data from the run are NOT imported into the database. The cause of the problem is determined and corrected, and the samples are re-analyzed. Problems are recorded in the sample queue's data spreadsheet, or on the handwritten runsheet associated with the run. Corrective actions (instrument maintenance and troubleshooting) are documented in each instrument's run log.

XI. Record Keeping Procedures

Protocols, Instrument Logs, QC charts, databases and all raw data files are kept on the lab manager's computer. These are backed up weekly, with the back up stored off site. The computer is password protected, and is only used by the lab manager. Protocols and the sample database are also password protected. Handwritten run sheets are stored in a filing cabinet in the lab. Instrument run and maintenance logs are combined with the QC data to form one large Excel file where instrument performance can easily be compared to instrument repair and the number of analyses, etc. This file is also stored on the lab manager's computer and is password protected.

All information pertinent to a sample is stored in the sample database. From this database we can easily determine the date of analysis and the location of the raw data file if

further review is necessary. The amount of information provided to sample originators is dependent on what is required by the project or funding agencies.

Table 1. List of standard operating procedures and description of analyses done at the Water Quality Analysis Laboratory.

Standard Operating Procedure	Analysis	Instrument Used	Description	Protocol Latest Revision	EPA method or other reference
Ion Chromatography Protocol for Anions and Cations Protocol	Anions and Cations	Ion Chromatograph	Anions via ion chromatography w/ suppressed conductivity. Cations via ion chromatography and conductivity	June 11, 2002	Anions EPA #300.1
Dissolved Organic Carbon Protocol	DOC	Shimadzu TOC 5000 with autosampler	High Temperature Catalytic Oxidation (HTCO)	June 25, 2002	EPA 415.1
Total Dissolved Nitrogen Protocol	TDN	Shimadzu TOC 5000 coupled with an Antek 720 N detector	HTCO with chemiluminescent N detection	June 25, 2002	Merriam et al, 1996
DOC and TDN combined Protocol	DOC and TDN	Shimadzu TOC-V with TNM nitrogen module	HTCO with chemiluminescent N detection	June 25, 2002	EPA 415.1 and Merriam et al, 1996
Lachat QuikChem AE Protocol	Nitrate/Nitrite colorimetric NO_3/NO_2	Lachat QuikChem AE	Automated Cd-Cu reduction	June 25, 2002	EPA 353.2
	Ammonium colorimetric NH_4		Automated Phenate	June 25, 2002	EPA 350.1
	Soluble reactive Phosphorous colorimetric PO_4		Automated Ascorbic acid	June 25, 2002	EPA 365
Acid Washing Protocol	Glass and plastic-ware cleaning		10% HCl rinse and 6 rinses with DDW	June 25, 2002	
Field Filtering Protocol	Sample prep		3-times rinse with filtered sample	June 25, 2002	

Table 2. Detection limits, acceptable ranges, and recent historical averages for QC samples

Analyte	Units	Typical Range	Regression Type	# of Cal. Points	Detection Limit [1]	MDL [2]	Duplicate % Relative Difference	Limit [3]	LFM % recovery	Limit [3] +/-	IPC % recovery	Limit [3] +/-
SiO_2	mg SiO2/L	0 – 40	Linear	4-7	0.3		3.5	15.0	92.8	15.0		
PO_4	µg P/L	0 – 200	Linear	4-7	2 – 3	1.5	7.8	15.0	95.5	15.0	93.7	15.0
NH_4	µg N/L	0 – 200	Linear	4-7	2 – 3	1.5	7.1	15.0	103.9	15.0	95.0	15.0
NO_3 FIA	mg N/L	0 – 10	Linear	4-7	0.05	0.003	4.6	15.0	100.9	15.0	102.6	15.0
Na^+	mg Na/L	0 – 15	Quadratic	4-7	0.1		0.9	15.0			112.7	
K^+	mg K/L	0 – 7	Quadratic	4-7	0.05		10.4	15.0			97.8	
Mg^{2+}	mg Mg/L	0 – 7	Quadratic	4-7	0.1		4.5	15.0			89.7	
Ca^{2+}	mg Ca/L	0 – 10	Quadratic	4-7	0.1		4.0	15.0			98.2	
Cl^-	mg Cl/L	0 – 15	Quadratic	4-7	0.2	0.02	1.6	15.0			92.7	
NO_3^-	mg N/L	0 – 3	Quadratic	4-7	0.002	0.002	0.3	15.0			96.3	
SO_4^{2-}	mg S/L	0 – 8	Quadratic	4-7	0.1	0.04	2.2	15.0			86.5	
TDN	mg N/L	0 – 10	Linear	4-7	0.1	0.029	7.8	15.0	100.3	15.0	102.1	15.0
DOC	mg C/L	0 – 20	Linear	4-7	0.1	0.048	4.9	15.0	100.5	15.0	97.0	15.0

References

Avanzino R.J. and V.C. Kennedy, 1993. Long-term frozen storage of stream water samples for dissolved orthophosphate, nitrate plus nitrite, and ammonia analysis. *Water Resources Research*, 29(10) 3357-3362.

Merriam, J.L, W.H. McDowell, W.S. Currie, 1996. A high-temperature catalytic oxidation technique for determining total dissolved nitrogen. *Soil Science Society of America Journal*, 60(4) 1050-1055.

APPENDIX C: Forms and Logbooks

Tributary Monitoring

Tributary Equipment Checklist

Required Equipment:	Present	Condition
1. Non-mercury Thermometer		
2. YSI 60 Portable pH Meter		
3. YSI 550A Portable Dissolved Oxygen Meter		
4. 2100P Portable Turbidimeter		
5. 4 - 250ml plastic sample bottles, screw top		
6. Cooler with Ice Pack large enough to store all of the samples and keep them cold.		
7. Deionized Water, enough to rinse all of the equipment before and after using.		
Personal Equipment you may wish to use:		
1. Bug Repellent		
2. Sun Screen		
3. Waterproof Boots		
4. Rubber Gloves		

Field Data Sheet

RIVERS Program
Green Mountain Conservation Group
2003 Season
"Regional Interstate Volunteers for the Ecosystems and Rivers Saco"

PART I – SITE AND SAMPLER IDENTIFICATION

Site Code Number_____ Sample Collection Date_____

Site Location_____ Sample Collection Time Begin/Finish_____

Field Samplers Names_____

Signature of Sampler_____

PART II – WEATHER CONDITIONS
Current Weather: □ Clear □ Partly Cloudy □ Mostly Cloudy □Fog □Haze □Sunny □Drizzle □Steady Rain □Downpour □Snow
(*check all that apply*)

Rainfall in previous 24 hours: □None □Light □Heavy _____inches

Source of rainfall information: _____ (*i.e. rain gauge, regional weather report, etc*.)

PART III – SITE OBSERVATIONS (*check all that apply*)
Water Appearance: □Clear □Milky □Turbid □Foamy □Oily □Light/Dark Brown □Greenish □Other (*explain*)_____

Water Odor: □None □Fishy □Chlorine □Rotten Eggs □Other(*explain*)_____

Wildlife Observations:_____

Floatable Observations (*i.e. leaves, foam, or debris*):_____

Bottom Observations (*i.e. color, bottom type, silt, rocky, algae, sand etc*.)_____

Local Observations (erosion, flooding, road work, littering or other disturbances)_____

PART IV – EQUIPMENT INFORMATION
pH Meter Used_____ Calibration Completed yes / no Time Completed_____ a.m. Volunteer Initials_____

DO Meter Used_____ Calibration Completed yes / no Time Completed_____ a.m. Volunteer Initials_____

Turbidity Meter Used_____ Calibration completed by water quality staff once every 3 months

PART V – FIELD MEASUREMENTS

Depth that measurements were taken_____ inches *(Indicate the depth of the **probe** in the water when taking the measurement).*

	Temperature	Turbidity	pH	Dissolved Oxygen	
Reading #1	° C	NTU		mg/l	% sat.
Reading #2	° C	NTU		mg/l	% sat.
	HACH Thermometer Reading ° C				
Averages (to be computed by staff)	° C	NTU		mg/l	% sat.

PART VI – SAMPLE COLLECTIONS

Time Silica, DOC,TDN, NH4, PO4, cations, anions sample collected	a.m.	Time Total Phosphorus sample collected	a.m.

REPLICATE SAMPLE COLLECTED? YES NO

Time Silica, DOC,TDN, NH4, PO4, cations, anions **replicate sample** collected	a.m.	Time Total Phosphorus **replicate sample** collected	a.m.

[redacted]

Additional Comments (i.e. problems with sampling procedures, etc.)_____

_____

Green Mountain Conservation Group Chain Of Custody

Project: **Project Managers: Dennis Finn and Blair Folts**

Sampled By: **Phone # : (207)625-8123 and (603)539-1859**

Site # and Sample ID	Date of Sample	Time of Sample	Type of Discharge	Matrix	Type of Container	# of Containers	Sampler's Name (J. Doe)	Analysis	Preservative Used	Comments

Relinquished By:_____ Date:_____ Time:_____ Received By:_____

Relinquished By:_____ Date:_____ Time:_____ Received By:_____

Relinquished By:_____ Date:_____ Time:_____ Received By:_____

Relinquished By:_____ Date:_____ Time:_____ Received By:_____

Relinquished By:_____ Date:_____ Time:_____ Received By:_____

Discharge Type: River, Lake, Pond, Other Matrix: Water, Wastewater

Apporval: To Be Filled In By Field Leader - Initials: Date:

Figure 1 Sample Page of Calibration Logbook

Calibration Log Book

Calibration of equipment should be documented below.

Note: Dissolved Oxygen and pH meters will be calibrated every morning that the meters are used, by the first person using them. If problems are experienced during calibration, note this in the comments section and then document the problem in the Equipment Log Book.

Equipment Calibrated	Calibration Performed By	Date	Time	Initials	Comments

Figure 2 Sample Page of Equipment Logbook

Equipment Log Book

If problems are experienced with the equipment (through calibration or use), please document the problem below.

Equip. Used	User's Name	Site/Place Where Used	Date	Time	Problem & Action Taken	Initials

New Hampshire Volunteer Lake Assessment Program
2003 Sampling Season

Field Data Sheet

25. Lake Name: _____

Town: _____

26. Field Monitors:_____ Date Sampled: _____

_____ Time Sampled: _____

Bottom Depth at deep spot:_____m

WEATHER CONDITIONS (Circle one for each):

Cloud Cover	Air Temperature	Wind Conditions	Water Surface	Lake Level
clear	<40° cold	calm	calm	high
hazy	41°-60° cool	breezy	ripples	normal
partly cloudy	61°-80° warm	strong	small waves	low
overcast	**>80° hot**	**gusty**	**moderate waves**	
			white caps	

PRECIPITATION CONDITIONS ***(Check off all that apply):***

Raining while sampling:_____ Rain in previous 24 hrs:_____ Rain in previous 72 hrs:_____

Indicate how much rain:_____ OR **No rain for past _____ days**

SAMPLING REMINDERS

1. Bring your NHVLAP Monitors field manual for reference.
2. Bring your VLAP clipboard. Compare plants in the lake to the drawings of the plants on clipboard. Collect samples of unfamiliar or suspicious looking plants and bring to the lab for identification.
3. Before filling up the deep spot sample bottles, check to make sure there is no sediment in the Kemmerer Bottle.
4. Rinse the big white and big brown bottles with sample water. Do not rinse the small brown bottle or sterile *E.coli* bottle.
5. Fill all sample bottles up to the bottom of the neck of the bottle.
6. Bring a cooler with ice out into the field and keep samples on ice.

7. Return samples on ice to the lab within 24-hours of sample collection.
8. Notify the lab in advance when you will be returning samples.

DEEP SPOT SAMPLES *(Large White **and** Small Brown Bottle (with acid) **at each depth** taken with Kemmerer bottle):*

Sample Depths (**meters**): _____, _____, _____

CHLOROPHYLL-A SAMPLE *(One Large Brown Bottle, does not contain acid):*

Sample Depth: _____m

Method: **Composite** ☐

(**NOTE:** Sample collected at **every** meter from the middle layer if there are three layers to surface, or from 2/3 depth to the surface if there are 1 or 2 layers)

Integrated Tube ☐

(**NOTE**: Please contact the VLAP Coordinator for instructions)

5.

6. SECCHI DISK TRANSPARENCY

Reading 1 _____m Disk visible on bottom? ____yes ____no

Reading 2 _____m Average _____m **(OVER →)**

TRIBUTARY SAMPLES COLLECTED *(please list station names & check off samples collected):*

Station Name	Big white bottle (pH, turb., cond.)	Sm. brown bottle (TP)	Sm. white bottle (*E.coli*)	Other (specify)

MONITOR TRAINING QUALIFICATIONS:

Did one monitor who sampled today attend the VLAP Refresher Workshop this spring? **YES** **NO**

If "**NO**": Did at least one monitor who sampled today already sample with the DES Biologist this year during the annual visit? (circle one) **YES** **NO**

*If "**NO**": Were you trained by another experienced volunteer this season?* ***YES*** ***NO***

*If "**YES**", please list name of volunteer who trained you:*_____

*If you answered **"NO"** to the above three questions, please briefly describe your sample collection training:*

NEW SAMPLING LOCATION:

Did you sample at a new location this sampling event? (Circle one) **YES** **NO**

If "**Yes**", please provide the following information:

Station Name:_____

Type of Station *(specify in-lake, inlet, outlet)*:_____

Station Location: *(Please provide one of the following pieces of information)*

1. Latitude/Longitude Coordinates: GPS coordinates: _____°N Lat,_____°W Long

Specify make and model of GPS:_____

OR **2. A map with the approx. location of station.** *(Please submit map and indicate location)*

Directions to Station: *Please provide written directions to new station from a known point (such as a public boat launch, bridge, or roadway intersection):*

FIELD OBSERVATIONS *(Please note tributary flow, tributaries that have dried up, recent storms/droughts, algal blooms, suspicious looking plants, wildlife observed, sampling problems, equipment problems, and other things of concern):*

☐ Please check and leave phone # if VLAP Coordinator should note immediately.

2003 VLAP VOLUNTEER MONITOR FIELD SAMPLING PROCEDURES ASSESSMENT

(TO BE COMPLETED BY THE VLAP COORDINATOR OR VLAP INTERN ON THE ANNUAL VISIT AND THEN TO BE FILED WITH ORIGINAL FIELD DATA SHEET)

Lake Name: _____ Date: _____
Town Name: _____ Time: _____
Volunteer Monitors: _____ DES Staff: _____
_____
_____

SAMPLING ISSUE	ASSESSMENT RATING		COMMENTS
	NEEDS IMPROVEMENT	GOOD	
I. PREPARATION FOR SAMPLING			
1. Anchor with enough line to anchor at deep spot			
2. Life vests for everyone on the boat			
II. DEEP SPOT SAMPLING			
Locating the Deep Spot(s):			
1. Indicate method used to locate deep spot: *circle: triangulation, GPS, depth finder, depth measurement with Kemmerer bottle, other (specify):_____*			
2. Kemmerer bottle set up properly			
3. Kemmerer bottle filled with water used to check the bottom depth (*this is called sounding*)			
4. Depth of deep spot written on data sheet			
Sample Collection:			
Deep spot samples (in general):			
1. White bottle rinsed with sample before filling			
2. White bottles filled to the neck			
3. Total phosphorus bottles were not rinsed			
4. Total phosphorus bottles were not over-filled			
5. Samples collected at the appropriate depths (*depths pre-determined by the DES biologist*)			
Bottom samples:			
1. After sounding, bottom sediments allowed to			

settle out before collecting deepest sample			
2. Bottom sample checked for sediment before filling bottles			
Chlorophyll-a sample:			
1. Indicate method used to collect sample (*composite or integrated sampler*):			
2. Bucket rinsed with lake water and discarded			
Composite method:			
1. Kemmerer bottle lowered to appropriate depth			
2. Water collected at each meter to surface			
3. Brown bottle rinsed with sample before filled			
4. Brown bottle filled to the neck with sample			
Integrated sampler method:			
1. Integrated tube set up correctly			
2. Weighted end & chain lowered to same depth (no slack in tube or chain)			
3. End of tube crimped tightly			
4. Weighted end hauled up by chain only (not tube)			
5. Weighted end placed in bucket and crimped end lifted above head and then uncrimped *(open end of tube should always higher than water level in tube)*			
6. Brown bottle rinsed with sample before filled			
7. Brown bottle filled to the neck with sample			

ISSUE	ASSESSMENT RATING		COMMENTS
	NEEDS IMPROVEMENT	GOOD	
Transparency			
1. Secchi disk properly set up			
2. Readings taken on the shady side of boat			
3. Disk lowered until it just disappears			
4. Disk pulled up until white portion just appears			
5. Chain grabbed at water level and depth estimated to tenths of a meter			
6. One reading taken by at least two monitors			
III. TRIBUTARY SAMPLING			
1. Sample not taken if tributary is not flowing or is too shallow to avoid disturbance to bottom and noted on data sheet			
2. Sample taken upstream if sediment disturbed			
3. White bottle was rinsed with sample by scooping into the flow, discarded downstream, and then bottle refilled			
4. TP bottle was not rinsed with sample			
5. TP bottle was filled from white bottle			
6. TP bottle was not over-filled			
7. White bottle was refilled or topped-off to the neck of the bottle			
IV. BACTERIA SAMPLING			
1. Sterile small white bottle used for collection			
2. Cap was removed just prior to sampling at site			
3. Care was taken to avoid touching the neck, inside the bottle, or cap			
4. Lake water: sample taken at approx. knee depth			
5. Flowing stream: sample taken midway b/w top & bottom of water, in upstream direction			
6. Mouth of bottle pointed towards water surface, submerged completely, and then used to scoop			

water in an upward "U-shaped" motion away from the person taking the sample			
7. Bottle was not rinsed with sample to avoid contamination			
8. Bottle was filled completely with no air bubbles			
9. Efforts made to avoid getting sediment and debris in sample			
V. SAMPLE LABELING			
1. Bottles properly labeled with waterproof pen *lake name, station, date, time, depth (for deep spot)*			
VI. FIELD DATA SHEET			
Data sheet was properly filled out			
One field data sheet per deep spot filled out			
VII. CORRECTIVE ACTIONS			
Were monitors notified of methods that need improvement? Yes____ No____			
Were monitors re-trained by the biologist in areas needing improvement? Yes____ No____			
Any other corrective actions necessary? Yes____ No____			
If "Yes" specify additional corrective actions necessary:			

Signature (monitors): _____
Signature (DES biologist):_____

VLAP SAMPLE RECEIPT CHECKLIST 2003

(TO BE COMPLETED BY LABORATORY STAFF ONLY
FOR EACH SET OF SAMPLES THAT ARE DROPPED OFF
AND THEN TO BE FILED WITH ORIGINAL FIELD DATA SHEET)

Lake Name: _____

Town Name: _____

Date samples received: _____
Time samples received: _____
Date samples collected: _____
Time samples collected: _____

SAMPLING ISSUE/SAMPLE REJECTION CRITERIA	YES	NO	COMMENTS/SAMPLES AFFECTED/SAMPLES REJECTED
27.1. HOLDING TIME			
Were samples returned to the lab within 24 hours? ***Sample Rejection Criteria:* If samples were returned between 24-48 hours after collection, note in the Log-in system. If returned after 48 hours, reject samples for analysis.**			***If "No"** then indicate how many hours since samples were taken: _____* ***Were samples rejected?** Yes ___ No ___*
Were samples "cooled" after collection? ***Sample Rejection Criteria:* If no attempt was made to "cool" samples for the period after collection and until brought into lab, then the samples should be rejected for analysis.**			***Specify method for cooling:*** *ice___ cold pack___ refrigerated cooler___ nothing___ other (specify):_____* ***Were samples rejected?** Yes ____ No __*
2. FIELD DATA SHEET			
Was the data sheet adequately & completely filled out?			***Specify problems:***
Were at least two Secchi-disk transparency readings taken?			
Was one field data sheet submitted per deep spot?			
3. COMPLETENESS OF SAMPLE SETS			
How many samples were brought in? # big white bottles: _____ # TP bottles: _____ # plankton bottles:_____ # Chlorophyll bottles: _____ # E. coli bottles: _____			
Were complete sets of samples brought in? *(1 TP sample for every big white bottle and 1 chlorophyll sample per deep station?)*			***Specify problems:***

4. CONDITION OF SAMPLES			
Were the correct bottles used for sample collection? ***Sample Rejection Criteria:* Samples that were not collected in the proper bottles should be rejected for analysis.**			***Were samples rejected?*** *Yes ___ No ___* ***Specify Samples rejected**:*
large white bottle = pH, ANC, conductivity, turbidity			
small brown bottle = TP			
big brown bottle = chlorophyll-a			
sterile small white bottle = E. coli			
Were bottles adequately & completely labeled? *(lake name, station, date, time, depth)*			***Specify problems:***
Was the condition of samples acceptable? *(leakage?)*			***Specify problems:***
5. SAMPLE VOLUME			
Do the bottles contain the appropriate volume of sample?			
Big white bottles: up to the neck of the bottle?			
TP bottles: up to the neck of the bottle?			
7. The TP bottles do not appear to have been overfilled?			
E.coli bottles: completely full with no air bubbles?			
6. SAMPLE CLARITY			
Are samples free from sediment?			
Are samples free from organic material (& plants)?			
Are samples free from color?			***If "no", specify samples & color:***
7. SAMPLE PRESERVATION			
Is the pH of each TP samples 2 or less?			***If "No", preserve samples immediately.***
8. CORRECTIVE ACTIONS			
Did monitors follow all proper sampling procedures?			
If "no", were the monitors contacted about problems?			
Specify when contact was conducted:			
Specify how contact was conducted *(in-person, phone, email, mail):*			
Specify staff person who contacted monitor(s):			
Indicate monitor's response: will re-sample___ will improve future performance___ other *(specify):* _____			

SAMPLE LOG *(Please fill out briefly at the lab bench and then bring to the computer to assist with logging in the samples)*

Sample Name	White bottle	TP	E.coli	Chlorophyll-a	Plankton	Other (specify)

APPENDIX D: Safety protocol

The camps participating in the Water Quality Monitoring program have varying sets of boating safety protocols that will be followed throughout the program. All of the protocols reflect the principals embodied in the following accreditation standards of the American Camping Association:[1]

*PA-20 - Watercraft Supervisor Qualifications-Youth - Youth groups must have an appropriately certified instructor or lifeguard for boating activities.

*PA-22 - First Aid/CPR - Camp must have an appropriately certified first aid/CPR person at each separate boating location.

PA-23 - PFDs - All persons in watercraft must wear safe and appropriate PFDs.

PA-25 - Watercraft Activity Orientation - Participants must know how to enter and exit a boat, use PFDs, and how to react if boat capsizes.

PA-26 - Watercraft Instruction - Boating instructors must be appropriately trained and certified.

PA-27 - Motorized Watercraft Training - Boat drivers must be trained on laws, rules of the road, safe loading and unloading passengers, mechanical failure, and refueling. On the water training also required.

PA-28 - Watercraft Maintenance - Camp boats must have safety checks and regular maintenance.

PA-34 - Camper Supervision - Staff accompanying campers to aquatic sites away from camp must be trained their supervisory roles and responsibilities.

[1] American Camping Association; Accreditation Standards, 1998.

APPENDIX E - Important Water Quality Factors

Total Phosphorus

Phosphorus is the most important water quality parameter measured in New Hampshire's lakes. It is the nutrient that limits algae's ability to grow and reproduce. Phosphorus sources around a lake typically include septic systems, animal waste, lawn fertilizer, road and construction erosion and natural wetlands.

Table 12: Total Phosphorus (TP) Ranges for New Hampshire Lakes & Ponds

TP (ug/1)	Category
1 – 10	Low (Good)
11 – 20	Average
21 - 40	High
> 40	Excessive

pH

pH is measured on a logarithmic scale of 0 to 14. Lake pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish.

Table 13 : pH Range Classifications

pH (units)	Category
< 5	Acidified
5.0 – 5.4	Critical
5.5 – 6.0	Endangered
6.1 – 8.0	Satisfactory

Acid Neutralizing Capacity (ANC)

Buffering capacity, or acid neutralizing capacity (ANC), describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. Historically, the waters of New Hampshire have had low ANC because of the prevalence of granite bedrock. The relatively low ANC value means that NH surface waters are vulnerable to the effects of acid precipitation.

Table 14 : ANC Range Classifications

ANC (mg/l as CaCO3)	CATEGORY
< 0	Acidified
0 - 2	Critical
2 – 5	Endangered
5 – 10	Highly Sensitive
10 – 20	Sensitive
> 20	Not Sensitive

Conductivity

Conductivity is the numerical expression of the ability of water to carry an electrical current. The number of ionic particles present determines its amount of conductivity. The soft waters of New Hampshire have traditionally had low conductivity values. High conductivity may indicate pollution from such sources as road salting, faulty septic systems or agricultural run-off. Specific categories of good and bad levels cannot be constructed for conductivity because variations in watershed geology can result in natural fluctuations. Values in New Hampshire's lakes exceeding 100 μmhos/cm, however, generally indicate cultural (man-made) pollutants.

Turbidity

Turbidity in the water can be caused by suspended matter, such as clay, silt and algae that cause light to be scattered and absorbed rather that transmitted in straight lines through water. High turbidity readings are often found in water adjacent to construction sites. Also, improper sampling techniques, such as hitting the bottom sediments or sampling streams with little flow may also cause high turbidity readings. The Class B standard for a water quality violation is 10 NTU's over the lake background level.

Table 15 : Statistical Summary of Turbidity Values for NH Lakes and Ponds

Turbidity (NTUs)	Category
< 0 – 1	Minimum
22.0	Maximum
1.0	Median

Chlorophyll-a

In deep water testing the measure of Chlorophyll-a, a pigment found in plants is used as an indicator of algae abundance. Because algae is a plant and contains chlorophyll-a, the concentration of chlorophyll-a found in the water provides an estimate of the concentration of algae.

Table 16 : Chlorophyll-a Ranges

Chlorophyll-a	Category
0 – 5 μg/l	Good
5.1 – 15 μg/l	More Than Desirable
> 15 μg/l	Nuisance Amounts

Water Clarity (Secchi Disk Transparency)

The Secchi Disk is a 20 cm disk with alternating black and white quadrants used to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, is affected by the amount of algae, color and particulate matter within a lake. Clarity values may vary depending on the maximum depth of the lake or pond. For example, if the maximum depth of the pond were 3 meters, a good clarity reading would be 2-3 meters.

Table 17 : Water Transparency

Water Clarity	Category
< 2 m	Poor
2.4 – 4.5 m	Good
> 4.5 m	Exceptional

Phytoplankton

Phytoplankton is microscopic algae floating in the water column. The type of phytoplankton present in a lake can be used as an indicator of general lake quality. An abundance of blue-green algae may indicate excessive phosphorus concentrations or that the lake ecology is out of balance. Diatoms and golden brown algae are typical of NH's less productive lakes.

Table 18: Types of Phytoplankton Common in Fresh Water Lakes

Greens		
Actinastrum	Micractinium	Spirogyra
Arthrodesmus	Mougeotia	Staurastrum
Dictyosphaerium	Pandorina	Stigeoclonium
Elakotothrix	Pediastrum	Mothrix
Eudorina	Scenedesmus	
Kirchneriella	Sphaerocystis	
Diatoms		
Asterionella	Pleurosigma	Surirella
Cyclotella	Melosira	Synedra
Fragilaria	Rhizosolenia	Tabellaria
Dinoflagellates		
Ceratium	Gymnodinium	
Cyanobacteria		
Anabaena	Chroococcus	Microcystis
Aphanizomenon	Lyngbya	Gloeotrichia Oscillatoria
Coelosphaerium	Aphanocapsa	
Golden-Browns		
Chrysosphaerella	Mallomonas	
Dinobryon	Uroglenopsis	
Synura		

Dissolved Oxygen and Temperature

The presence of dissolved oxygen is vital to bottom-dwelling organisms as well as fish and amphibians. If the concentration of dissolved oxygen is low, species intolerant to this situation, such as trout, will be forced to move or may not survive.

Temperature is also a factor in the dissolved oxygen concentration. Water can hold more oxygen at colder temperatures than at warmer temperatures. Therefore, lower concentrations of dissolved oxygen will be found in the summer.

By measuring the dissolved oxygen and the temperature at set intervals from the bottom of the lake to the surface, the thermal stratification can be determined as well as the lake oxygen content. Usually a drop in dissolved oxygen will be found in the deep waters as the summer progresses.